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Journal

of the

American Ceramic Society

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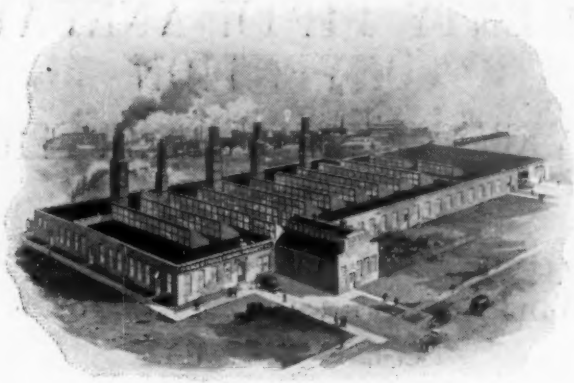

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The Secretaries of the Industrial Divisions have secured most valuable papers, and the Pittsburgh local committee have arranged for a most enjoyable and profitable week.

Members are requested to extend a cordial invitation to all who might be interested in attending and in participating in the meetings and social affairs of the week.

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Vol. 6 January, 1923 No. 1

A REVIEW OF TWENTY-FIVE YEARS IN CERAMICS

It was designed that this number of the *Journal* should be a review of the past twenty-five years in ceramics. It was thought this would be a rather easy undertaking with several collaborating, and that two months was ample time and two hundred pages ample space. We believe we need not apologize for the inadequacies of this review. If we have established the fact that a great deal has already been accomplished with very little coördination in effort between the industries and the purely research agencies, and that vastly more would surely be accomplished through a more thorough coördination of all the industrial, technical and scientific agencies, this review will not have been in vain. This coördination of the several agencies in ceramic research and in the industrial application of the results of researches is the program on which the AMERICAN CERAMIC SOCIETY has been collaborating with other organizations with success.

This SOCIETY is entering onto its twenty-sixth year of activities. It will celebrate its twenty-fifth anniversary in a befitting manner during the week of February 12 in Pittsburgh, but its record of activities and growth during the past quarter century are set forth in the following pages.

THE AMERICAN CERAMIC SOCIETY

HISTORICAL STATEMENT OF THE ORIGIN OF THE AMERICAN CERAMIC SOCIETY

By Edward Orton, Jr.[1]

The circumstances or events which led up to the founding of this Society, though they are in themselves unimportant and received at the time of their occurrence but little consideration from any one, have been collected and presented in this statement in the belief that if the Society becomes in future years an adequate representative of the industries for which it stands, its early history will then become of great interest to its membership and it will be difficult or impossible to procure the facts.

At the 12th Annual Convention of the National Brick Manufacturers' Association of the United States of America, held in Pittsburgh, Pennsylvania, on February 15, 16, 17 and 18, 1898, a very excellent paper was read by Mr. Elmer Ellsworth Gorton, of Terra Cotta, Illinois, on the subject of "Experimenting, Wise and Unwise." In this paper Mr. Gorton set forth in illustration of his ideas the results of some of his own experiments in the adaptation of a glaze to a terra-cotta body, writing the chemical formulae of his glazes on the blackboard, and making the necessary calculations to compute the weights of the ingredients needed to make them, before the assemblage. Each experiment was further illustrated by means of trial pieces, showing the result of each modification in composition or treatment which appeared in the text.

This paper was the first of its kind on a chemical topic which had appeared before that Association, and while the novelty of the scientific method of presentation, which Mr. Gorton had adopted, held the interest and attention of the members, it was apparent to all that any extensive addition of this sort to the programs of the Association would be unwelcome, on account of the comparatively small proportion of the members who could understand or follow them.

During the evening of the same day, Mr. Gorton and Mr. Samuel Geijsbeek of New Brighton, Pa., approached the writer and laid before him a scheme which they had jointly prepared subsequent to the reading of Mr. Gorton's paper. This scheme was to form a small Society, which should be a section of the National Brick Manufacturers' Association, or independent of it, as might be thought best, but which should meet at the same time and place as the N. B. M. A., in order to enable the members to maintain their affiliation with that Association. The new Society was to be composed only of Ceramic Chemists or those who would understand ceramic work from the scientific side and would be willing to share their information with their fellow members.

[1] Written in 1899.

This idea matured very rapidly during that day and the 17th of February following. On canvassing the members of the N. B. M. A. present, it was found that only a small number would in any degree fill the technical requirement roughly sketched above, but the following gentlemen were invited by the two original projectors, the writer, and Mr. Albert V. Bleininger, who was early taken into the counsel of the three first named, to meet on the evening of February 18, in the parlors of the Monongahela House and discuss the proposition and if possible form a provisional organization, *viz.*— Messrs. Elmer E. Gorton, Samuel Geijsbeek, Edward Orton, Jr., Albert Victor Bleininger, Willard D. Richardson, Ellis Lovejoy, William D. Gates, Carl Giessen and Gustav J. Holl.

All of the gentlemen invited, reported, and a very enjoyable evening was spent in discussing the plan proposed. No officers were elected except the writer, who was asked to act as provisional secretary. The topics discussed were (1) the qualifications for membership in the Society, (2) the name of the Society, (3) the methods of procedure to bring the desirable elements together for the first meeting. The sense of the meeting in regard to the first topic was expressed in the following sentence written at that time:—

"Membership shall be selected from those who are actively engaged in technical ceramic operations, and who are qualified by education and experience to contribute to the advancement of the Ceramic Arts." The second topic was discussed at length, but after many suggestions it was thought best to take no action pending the formal organization of the Society. The discussion of the third topic resulted in the adoption of the following plan: That a document, calling for a meeting one year from date, to be held with the meeting of the N. B. M. A., should be at once drawn up and signed by the nine gentlemen present, and, subsequently, an extended statement, setting forth the aims and objects of the proposed Society, should be made by the provisional secretary, and attached to this "Call" as an explanation to those who might be invited to sign the Call, but who had no knowledge of the sentiments actuating the framers of the Call.

The list of persons who should be invited to join in the formation of the proposed Society was then taken up and the following list was agreed upon:—

Karl Langenbeck and Herman Mueller of the Mosaic Tile Company of Zanesville, Ohio; Ernest Mayer, of the Mayer Pottery Company, and F. W. Walker of the Beaver Falls Art Company of Beaver Falls, Pa.; Henry R. Griffin of Phoenixville, Pa., author of "Clay Glazes & Enamels;" Dr. W. H. Zimmer, Chemist of the Wheeling Pottery Company; Edward C. Stover, Assistant General Manager of the Trenton Potteries Company, Trenton, New Jersey; James Pass, Manager of the Onondaga Pottery Company, Syracuse, New York; Prof. H. A. Wheeler, formerly on the

Geological Survey of Missouri, and now Manager of the Standard Tile Company, St. Louis, Mo.; Prof. H. Ries of Columbia University and U. S. Geological Survey; Stanley G. Burt, Chemist of the Rookwood Pottery Company, Cincinnati, Ohio; Charles F. Binns, late of the Royal Worcester Pottery of England, and now with the Ceramic Art Company, Trenton, New Jersey; J. Parker B. Fiske, of Fiske, Holmes & Company, Boston, Mass.; and Dr. Oscar Gerlach of La Salle, Illinois, formerly with the Versuchs Austalt für Keramischer Producten in Berlin.

The document agreed upon as a Call for the meeting was then drawn up and made to read as if already attached to the longer preamble before described, and was signed by the members of the meeting who were present, their names forming the first nine names on the list.

The close of the Convention of the N. B. M. A. occurred the next day, and nothing more was done concerning the new Society till March 1, 1898, when the writer, acting as Secretary, prepared the following preamble to the Call, and began circulating the document among the list of gentlemen agreed upon. The results of this work, which was begun March 11, and was concluded about June 1, 1898, and which was carried on entirely by mail, are shown in the following original document which is here incorporated and made a part of the record.

COLUMBUS, OHIO, March 1, 1898.

At a meeting of the National Brick Manufacturers' Association held at Pittsburgh, Pa., in February, 1898, a small number of members of this Association became imbued with the idea that this Association did not afford a wholly satisfactory means of exchanging ideas on the various branches of ceramic technology, in which they were interested, on the following ground: Papers read at the meeting at Pittsburgh and occasionally in preceding meetings, which touch comparatively lightly on scientific grounds, have, it has appeared, been more complex than the rank and file of the membership of the Association have cared to discuss.

There is a very wide range of subjects which are practically barred for this reason from discussion in the Association's meetings, and yet which seemed to these gentlemen to be of the greatest personal and scientific interest. Accordingly, the idea arose among them that the proper development of their own knowledge and scientific attainments demanded some subdivision of the Association's work. Some discussion was had as to the best means of effecting this end, whether by the formation of a section in the N. B. M. A., or by a completely separate organization, devoted to the kind of work in which they were jointly interested.

I was asked as provisional secretary of this body of gentlemen to draw up this following statement, setting forth the facts, with a view to determining whether it is probable that any such plans as we have in mind

will receive sufficient endorsement by educated clay workers in this country to make them likely to be successful.

It is especially desirable in the outset, to make it clearly understood that we mean no harm, present or future, to the N. B. M. A., to which organization all of the originators of this plan belong and to which they are attached by many ties of friendship and good-will. Our position is not meant to be, nor will it be allowed to become, in any way antagonistic to the older organization, which has done so much towards improving the condition and elevating the status of the common clay industries of the country. But the nature of this organization, and its membership, absolutely preclude its ever becoming in any degree a scientific organization; if it did become such a one, it would at once cease to do the greatest good with the greatest number of its constituents, and would, therefore, soon expire.

We believe that there are at present in the United States quite a number of gentlemen, not affiliated with the N. B. M. A. or any technical scientific organization which gives a proper field for the discussion of the many problems of ceramic technology, who are vitally interested in the discussion of just such things, and who would welcome an opportunity to meet others in an Association where these subjects would receive a full, free and frank discussion for the mutual interest and progress of all concerned. Inasmuch as the ceramic industries of the country so far maintain no organizations other than purely commercial ones, with the single exception of the N. B. M. A., we hope to gather together from all branches of the ceramic industry a number of men who will not only be interested in such a program as has been indicated, but who will also be able both by intellect and education to make substantial contributions to it.

The subjects which we wish to discuss are those connected with the application of science to the practical needs of the clay industry. Naturally, the chemical technology of the clay industry will receive quite a large part of our attention, but the physics of drying and burning, the mechanics of manufacturing, and, in short, all and any branches of technology touching this great industry, will find welcome admission to our program.

The plan as roughly formulated is to have one meeting per year at the same place that the meeting of the N. B. M. A. is held, and either concurrently with it, or just before or afterwards. This time and date was chosen to allow all who wished to attend the meetings of both organizations without much increase of expense. Many of the new Association would still continue active members in the old one, and could not afford to attend separate conventions at different points and times. In addition, it can be said that many members of the new Association would certainly find pleasure and profit from the meetings of the N. B. M. A., and for the opportunities afforded by the machine exhibition rooms and social and

business acquaintances. Also, the hotel and railroad rates of the larger Association would make the expense to members of the small one less onerous.

In the informal discussions which were had at Pittsburgh a small list of names was compiled of persons whom we thought would care to join such an Association or, rather, help to organize such an Association, as we have in mind. This list comprizes, including ourselves, less than thirty names, and it was the sense of all, that this provisional list should be extended with extreme caution, if at all, until after the formal organization takes place.

In our discussions it has been thought best that we should make no constitution or by-laws, or that we should attempt to formulate definitely either a name or a policy, but, in a general way, the points which we have in mind to accomplish are these:—

First: The Association shall receive a name which shall distinguish it as a scientific rather than a commercial organization, and which shall commit it to the investigation of the ceramic industry.

Second: Its membership shall be limited to such men as are not only able but willing to contribute something to the advancement of knowledge along these lines by means of such an organization. The status of its members in the industry commercially, shall not be of importance in determining their attendance to the Association. Their interest in the work and their attainments as ceramic technologists only will be considered.

Third: It is proposed at a meeting to be held in February, 1899, at whatever city the National Brick Manufacturers shall designate for their meeting, to organize the new Association along the lines which have here been roughly sketched out. If a sufficient number sign the accompanying agreement in due season, it is also proposed that the meeting be definitely called and the prospective members be asked to prepare papers, so that our first meeting shall accomplish something besides mere organization.

I am empowered by the originators of this plan to invite you to become one of the charter members of the proposed Association. If you feel disposed to accept this opportunity, I should be glad to have you sign the attached statement.

Yours very truly,
(Signed) Edward Orton, Jr., *Provisional Secretary.*

P. S. The first nine signatures on the accompanying agreement represent the originators of this plan, under whose instructions I am acting in preparing this letter:

"We, the undersigned, hereby state that we are in cordial sympathy with the objects which are set forth in the accompanying circular letter,

relative to the formation of an Association of those who are interested in the ceramic industries in their technical and scientific aspects. We regard this as a much needed step in the direction of progress, for ourselves, individually, and for the ceramic industries of this Country.

"We hereby agree to be present, if possible, at a meeting to be held in February, 1899, at a place to be decided later, there to organize such an Association, and to hold a meeting for the reading and discussion of papers."

S. Geijsbeek, Chemist, Sherwood Bros. & Co., New Brighton, Pa.

E. E. Gorton, Chemist, American Terra Cotta & Ceramic Co., Chicago.

Edward Orton, Jr., Dept. Clay Working & Ceramics, Ohio State University.

Wm. D. Gates, Pres. American Terra Cotta & Ceramic Co., Chicago.

W. D. Richardson, Gen. Manager, Ohio Mining & Mfg. Co., Shawnee, Ohio.

G. J. Holl, Manager of the Ohio Ceramic Engineering Co., Cleveland, Ohio.

Albert V. Bleininger, Appointee to the N. B. M. A. Scholarship, 1897–98.

Ellis Lovejoy, Supt., The Columbus Brick & Terra Cotta Co., Union Furnace, O.

Carl Giessen, Royal Brick Co., Canton, O.

Ernest Mayer, The Mayer Pottery Co., Ltd., Beaver Falls, Pa.

F. W. Walker, Sec. & Supt., Beaver Falls Art Tile Co., Ltd., Beaver Falls, Pa.

H. Ries, U. S. Geological Survey, Columbia University, N. Y. City.

Herman C. Mueller, Supt., The Mosaic Tile Co., Zanesville, O.

Karl Langenbeck, Supt., The Mosaic Tile Co., Zanesville, O.

H. C. Wheeler, Manager, Standard Tile Co., St. Louis, Mo.

W. H. Zimmer, Ph.D., The Wheeling Pottery Co.

Chas. F. Binns, Superintendent of Technical and Art School, Trenton, N. J.

Edward C. Stover, Assistant General Manager, The Trenton Potteries Co.

Stanley G. Burt, Chemist, Rookwood Pottery.

James Pass, Gen. Mgr., Onondaga Pottery Co., Syracuse, N. Y.

Henry R. Griffen, C.E., Phoenixville, Pa.

J. Parker B. Fiske, Boston, Mass.

The completion of the work was announced to the various gentlemen who had thus identified themselves with the proposed Society, by a circular letter, which was prepared on August 6, 1898, and mailed to each member on August 8.

The following is a copy of the letter:—

COLUMBUS, OHIO, Aug. 6, 1898.

Mr. Samuel Geijsbeek,

New Brighton, Pa.

My dear Sir:—

I hand you herewith a list of the signers who have agreed to meet in February, 1899, at a time and place to be designated later, for the purpose of forming an Association of those interested in the technology of the Ceramic Industry. While the above list is not a large one, I think that you will agree with me that it is a very good one and that it comprizes very many of the best known men in this branch of learning in the United States. The need for the Association seems recognized by all who have been approached on the subject and it is my pleasure to announce that every invitation to sign the list has met with a willing response. The meeting place for the coming first meeting cannot yet be announced, but it seems advisable that some arrangement should be set on foot to insure not only the organization of the new Association, but that its first meeting should bring forth some interesting papers and discussions. In fact, with so small a membership, it is likely that the duties of organization and the outlining of our future policy as to extension and the work will occupy a comparatively short time, and the interest and pleasure of the occasion will be greatly heightened if a program other than business can be arranged. Accordingly, I must request each one of you to come prepared with a paper or note or some specific item of interest as his contribution to our first meeting. Furthermore, I will ask that each member notify me as early as possible of the subject which he will discuss, so that a program or announcement can be publicly made before the date of the meeting. There are also other matters which have been suggested as very properly coming before our Association. Among these, the one seeming to awaken most general interest is the matter of securing an American edition of Seger's "Gesammelte Schriften," a book which is destined to become a classic among all clay-workers. The translation of this volume, it would seem, could surely be accomplished without much labor under the auspices of our Association and would undoubtedly prove a further bond of unity between its members.

Congratulating the members on the excellence of the prospect for the Association and urging once more, the importance of immediate work on the part of each, I remain,

Very respectfully,

(Signed) Edward Orton, Jr., *Provisional Secretary.*

The Provisional Secretary received many favorable comments and letters of congratulation and promises of active support in the movement in reply to this letter.

Nothing further was done until December 27, 1898, when the following letter and list of questions was prepared and sent out to the mailing list:—

COLUMBUS, OHIO, Dec. 27, 1898.

My dear Sir:—

Pursuant to a promise, made in a circular letter which I sent you some months ago, I now write to inform you that the meeting of the National Brick Makers' Association will be held in this city, February 7 to 10, 1899. As the scheme of organizing the Association of Ceramic Technologists originated at the last meeting of the National Brick Makers' Association at Pittsburgh in 1898, and as at least one-half of the contemplated membership of the new Association are members also of the National Brick Makers' Association, and would wish to attend the meetings of the latter in any case, and also since our own membership will be so small as to make it difficult to secure the customary reduction in railroad rates given to Associations, it seems best to hold this first meeting of the new Association in Columbus at practically the same time as that of the Brick Makers.

It would also give me great pleasure to have the first meeting of the Association occur in this city and under the auspices of the University and my Department.

The meeting of the new Association ought either to lead or follow that of the Brick Makers. Since the latter will spend Friday of that week in the city, it would seem that it would be better to lead, rather than to attempt to follow their meeting. Their first session will occur at 2 P.M., Tuesday, the 7th, and every day and night until Friday night will be occupied. I would suggest that if our Association could meet for organization at the University, Monday afternoon, February 6, and hold an evening meeting the same day for the reading and discussion of papers, and another meeting on Tuesday morning, the 7th, for the same purpose and for closing up the details of organization and the adoption of the Constitution, etc., we would find in these three sessions time enough for the successful completion of all of the work of this first meeting. In case it should transpire that a little more time was desirable, I think without doubt the members of the Brick Makers' Association could excuse themselves from one of the sessions of the latter Association.

In order to decide this matter definitely, I will therefore ask each member to fill out the enclosed blank and mail it to me at the earliest possible date. I would also urge on each of you the desirability of having some paper, or subject for discussion, or note, to present before the Association at its first meeting. Our power to do ourselves and each other good, and

the future strength and influence of the organization on the Ceramic Industry of the country will depend very much on the way that this first meeting passes off. I earnestly hope that it will be a thoroughly successful meeting from the standpoint of the technical papers presented, and the discussions evoked, and that the whole spirit of the meeting will be one of enthusiastic work on the part of each member. To realize such an end, each one of us must be a contributor, be it ever so little, to the results of the meeting. For this reason, I beg you will fill out the enclosed blank in full.

Awaiting your reply, I remain,

Yours respectfully,

(Signed) Edward Orton, Jr., *Provisional Secretary.*

Questions

I—Will the date Monday, February 6, 2 P.M., to Tuesday, February 7, 12 M., suit you for the date of the first meeting?

II—If not, would a meeting February 11 and 12 suit you better?

III—Will you be present at the meeting so far as you can foresee?

IV—Please indicate here the final title of your paper as you wish it to appear on the program.

V—Please indicate here the subject of a short note, talk or informal discussion in which you will agree to take part.

VI—Please indicate here the subject of any question which you would care to have discussed, but in which you do not feel able to participate.

Please note that prompt replies will be necessary in order to permit the preparation and mailing of a suitable program.

Replies to this were received from twenty out of the twenty-two members of the list, and the indications for a literary program appeared so excellent that a formal announcement was prepared and sent out on February 1, 1899.

The first meeting of the SOCIETY occurred as set forth in the above circular and from that point forward its minutes tell its history with all the accuracy necessary.

This sketch is inserted at the head of the records of the AMERICAN CERAMIC SOCIETY, according to a resolution passed at the second meeting, July 4, 1899, and found in the minutes of that meeting.

TWENTY-FIVE YEARS OF THE AMERICAN CERAMIC SOCIETY

BY NORAH W. BINNS

Early Meetings

In accordance with the summons outlined in the foregoing statement, fifteen "signers of the Call" duly gathered at Columbus, Ohio, on February 6, 1899. The group was fully aware of the value of strong leadership

in the undertaking and promptly elected Edward Orton, Jr., Secretary of the SOCIETY, a position he held for nearly twenty years and the duties of which he executed with inspired faithfulness. H. A. Wheeler, of St. Louis, was elected first President, and S. G. Burt, of Cincinnati, was called upon to fill the office of Treasurer, to which he was reëlected at eight annual meetings.

A review of this meeting shows four characteristic actions of the SOCIETY, auguries of the attitude to be taken on certain large questions for the coming twenty-five years. That this is so, is cause for admiration and respect for the breadth and clearness of vision of the founders and charter members of the SOCIETY.

As a preparatory step a Constitution had been carefully drawn up prior to the meeting, and it is noteworthy that the SOCIETY operated under the rules then adopted without amendment until 1911. This small body of men showed themselves able to prepare a set of rules fitted to govern them unchanged for ten years and with certain modifications for twenty-five.

A second important and typical action was the proposal to translate into English the writings of Hermann A. Seger, pioneer scientific ceramist of the world. Thus the SOCIETY showed at once its desire and purpose to render real service to the industry at personal sacrifice and for no selfish end.

A third matter which was presented at the first meeting shows a keen interest in the attitude of the United States Government toward mines and mining, akin of course to ceramics, and a readiness to shoulder responsibility and to demand action from others.

The fourth side exhibited at that memorable meeting was the educational. Certain papers which were presented provoked plans for concerted action by the members. Committees were appointed to consider the testing of clays, and to make recommendations for the establishment of standard ceramic equivalent weights.

The SOCIETY thus put itself on record at its first meeting as a well-ordered body with definite rules and regulations, as a sponsor for scientific contributions to ceramic lore from other countries, as an advocate for government support of ceramic problems, and as a reasoning group proposing to put into execution the conclusions of its members.

With this beginning, annual meetings were held without interruption, the attendance growing, sometimes by twos and threes, sometimes by scores, but always growing. Summer excursion meetings were held with a few exceptions in the early years, when the Pan-American Exposition or the World's Fair proved too diverting. Since 1909 there has been no lapse in the summer meetings.

At the smaller meetings of the early years naturally the personal point of view was retained and emphasized. The elevation of associates to ac-

tive membership was always an occasion of dignity and solemnity. The President of the SOCIETY invariably invited the newly elected active members to the platform where he greeted them with words of congratulation and advice and hearty handclasps. The qualifications of an active member were brought out in many a presidential speech, first, that technical ability was required, and, second, that technical ability must be supplemented by a desire to impart his stores of knowledge and to serve his neighbor and mankind. The innate spirit of the charter members was thus inculcated in the recruits, who were able in their turn to lead.

Intimacy naturally marked the relations between these men who were drawn together by no slight bond. As much concern was felt for one another in time of illness, accident, or misfortune, as if they were members of the same family, and one cannot remain unmoved on reading the account of the solemn occasion of the announcement of the death of a charter member.

Another element which can never be found among the great numbers at our modern meetings is the spirit of Section Q. Ask any member of the first five years what he enjoyed most and he will say, "Section Q." The need for recreation was not satisfied by dancing and moving pictures. It was talk and more talk that these men craved. Formal papers were given morning and afternoon but in the evening, in a private room or

around a table, refreshments of the good old variety were made available, cigars and pipes were lit, and Section Q was on. Many of the members were working alone, so far as scientific sympathy or understanding was concerned. All of them had problems, all of them had a little knowledge. Put together, the bits of knowledge gradually began to penetrate the problems. Section Q was the earliest form of ceramic "coöperative research."

A portly professor at one Section Q was heard to say that he intended to catch the ten o'clock train for home. Shortly afterwards came the remark, "Why, it's ten-thirty now. Well, I'll take the midnight train." A few more experiences were exchanged and he cried, "Heavens, it's a quarter of one. I'll have to take the two o'clock." The historian does not know whether he actually made this train or not.

These staid professors and sober business men were like schoolboys when they met each other. On one occasion a charter member had to make a speech at the banquet of another organization, meeting at the same place. He stayed at his beloved Section Q as long as he could, then rushed away to keep his engagement. A loyal friend proposed that their group should support the speaker by going in a body to hear him, and so they did. But before their companion's speech they had to listen to an interminably long address by someone else. Worn out but at last able to get away they looked for the man who had suggested coming to the banquet, only to find that he had retired long since and was soundly sleeping. To make the punishment fit the crime, an urgent call for five A. M. was left at the clerk's desk for the sleepy one.

It is amusing to note the hotel rates which prevailed at the earliest meetings. All expenses for four days were estimated at ten dollars at one meeting. On the American plan, which was customary then, the hotels charged three dollars a day. The bill for the expenses of his office for the first year was deprecatingly presented by the Secretary since it amounted to more than he had anticipated. The total was twenty dollars and fifty cents. What the growth of the cash receipts of the SOCIETY has been is shown on the accompanying chart.

Seger's Collected Writings

As has been said, the translation of Seger's *Writings* was proposed at the first meeting. Several members who were conversant with German had offered to do parts of this work and it was promptly taken in hand, A. V. Bleininger serving as Editor. The size of the two volumes which were finally published is well known, and it will readily be seen that hard work was necessary to have the first volume ready for distribution at the fourth annual meeting of the SOCIETY, while the second was ready at the time of the fifth summer meeting. All of the work of translation was done by

members of the SOCIETY with no remuneration whatever. A subscription list was circulated and more than enough sales were made to satisfy the requirements of the publishers. The work is still considered authoritative and its comprehensiveness recommends it to students of all branches of ceramics.

Manual of Ceramic Calculations

Another important publication which was initiated at the first meeting was the *Manual of Ceramic Calculations*, as the report of the Committee on a Scale of Ceramic Equivalent Weights was afterwards called. This Committee did its work between the time of the first annual meeting and the second summer meeting, and its findings were reported in Volume II of the *Transactions*, the *Manual* being issued later as a reprint. This was in demand as a textbook for many years and requests for it are still received, although it is now out of print.

Incorporation

In 1905 it was found necessary for business procedure in the state of Ohio to incorporate the SOCIETY. Nine members, residents of Ohio, under the leadership of Professor Orton, signed the articles of incorporation, and all members were made parties thereof, by virtue of the signatures on their applications.

Ceramic Schools

From the first the SOCIETY staunchly supported the establishment and maintenance of ceramic schools. Ohio State's Ceramic Department preceded the founding of the SOCIETY by five years, while the New York State School of Ceramics followed it one year later. At its fourth meeting, the SOCIETY voted to send resolutions to the New Jersey legislature, urging the establishment of a department of ceramics at Rutgers College, evidently to some purpose, for at the fifth meeting a paper describing the new department was given. After the World's Fair at St. Louis in 1904, where the SOCIETY exhibited a set of its *Transactions* and was awarded a silver medal by the judges of technical literature, the books were donated as a nucleus for the library of this school. In 1907 resolutions were again sent to the New Jersey legislature endorsing ceramic education in general, setting forth the good that had been accomplished and urging increased appropriation for Rutgers.

Similar support was given from time to time to Illinois and the other ceramic departments as they came before the state legislatures.

Bibliography of Ceramic Arts

In 1906 Dr. J. C. Branner, of Stanford University, offered to the SOCIETY for publication a bibliography of ceramic arts, upon which he had

been working for some time. This offer was accepted with appreciation of its generosity, and Dr. Branner was made an honorary member of the SOCIETY. The volume was issued the same year.

Committee Work

Committees have always been integral parts of the SOCIETY. Sometimes conspicuous success followed their work, as has been described; sometimes, through lack of time or other reason, results were not seen for years.

A most important achievement was that of the Committee on Cooperation with Federal and State Geological Surveys. The appointment of this committee was prompted by the reading of a paper by Mr. R. R. Hice, State Geologist of Pennsylvania, at the 1906 annual meeting. The committee, of which Mr. Hice was made chairman, was not appointed until January, 1907, but began to work at once and at the next meeting a vigorous discussion took place, with contributions by Mr. H. Foster Bain, then Director of the State Geological Survey of Illinois, and Dr. E. R. Buckley, State Geologist of Missouri, in addition to the members of the SOCIETY who were in close touch with the work of the Surveys. The purpose of the Committee, then outlined, was to bring the influence of the AMERICAN CERAMIC SOCIETY upon the U. S. Geological Survey in the organization and operation of a clay-testing laboratory, and to confer with all the Surveys who were investigating clays, in the points to be covered by a geological report which should be of real service to ceramists.

The comprehensive report, written by Mr. R. C. Purdy, secretary of the Committee and ceramist of the Illinois Geological Survey, and printed in Volume IX of the *Transactions*, shows that in May, 1907, documents were spread before the U. S. Geological Survey, urging the creation of a laboratory for research in the testing of clays and clay products, to develop a system whereby other groups would be enabled to carry on practical applications and tests, and demanding the appointment of a scientific and technically trained ceramist to take charge of such a laboratory. Furthermore, the Committee outlined a method of attacking the problems, and the points to be covered, emphasizing that the investigations of the laboratory should be scientific rather than industrial. To the State Surveys, the Committee made recommendations that problems of a stratigraphic, areal, local economic or industrial nature should be investigated.

The results of this work are well known. A Structural Materials laboratory was established in the Technologic Branch of the U. S. Geological Survey and Mr. Bleininger was made director, with two other members of the SOCIETY on his staff. In 1909 a threatened curtailment of the appropriation for this branch put the AMERICAN CERAMIC SOCIETY on its mettle and a veritable flood of telegrams and letters to congress-

men effectually drowned out the voices of the over-economical, and the amount was made higher than before. Efforts were still put forth for the establishment of a federal bureau of mines and mining, and in 1910 the proposal met with favor and the bill was passed. At the same time the structural materials investigation was turned over to the Bureau of Standards, who retained the technical staff and continued the work. For some time the Bureau of Standards was the only federal body touching ceramics, but of late years both the Bureau of Mines and the Geophysical Laboratory have been initiating new work.

A step was taken toward a Committee on Standards at the first meeting of the SOCIETY but there were various lapses of appointment and no tangible work was accomplished for some years. In 1917 this Committee worked out tentative methods of clay testing, which were reported at the annual meeting in 1918. Two years of labor followed, revising and perfecting the tests, and six methods were finally adopted by the SOCIETY as standard in 1920. A sub-committee of the Committee on Standards in 1918 issued a *Directory of Dealers in Raw Ceramic Materials* which filled a need.

Committees on Ceramic Education, Nomenclature, War Service, etc., were appointed from time to time and did valuable work.

COÖRDINATING SERVICE COUNCIL

General Secretary, *ex-officio* Chairman

Four members, appointed by Board of Trustees to serve as Chairmen of Committees 1 to 4, inclusive

		Committee members	Coöperation with other organizations
1. Committee on Research	Pure Science Applied and Industrial Science	3 members appointed by Board 1 member chosen by each Division	National Research Council (Div. Chemistry and Chemical Technology, Div. Research Extension, and Div. Engineering) Federal Bureaus Semi-Public, Commercial, and Industrial Laboratories Universities Trade and Technical Associations
2. Committee on Standards	(*a*) Definitions (*b*) Raw Materials Specifications (*c*) Standardization of Tests (*d*) Standardization of Products	(*a*) 3 members appointed by Board (*b*) 3 members appointed by Board (*c*) 1 member chosen by each Division (*d*) 1 member chosen by each Division	American Society for Testing Materials (Committees C-1 to C-11, inclusive, D-4, and D-9) Foreign Ceramic Societies Trade and Technical Associations Federal Bureaus American Engineering Standards Committee, etc.
3. Committee on Geological Surveys	Advisory on Tests and Interpretation of Data	4 members appointed by Board	National Research Council (Div. Geology and Geography) U. S. and State Geological Surveys
4. Committee on Data	(*a*) Symposiums (*b*) Monographs (*c*) Bibliographies (*d*) Statistics	1 member chosen by each Division	National Research Council Trade and Technical Associations Federal Bureaus Commercial Laboratories Universities

Up to about 1909, as was right, new members were only those who asked for admission, but now there was evident need for increased strength in numbers and finances, and the first indication of the modern campaign can be seen in the slogan sent out by the dignified Secretary, "Land a new member and sell him a set of the *Transactions*,"and the Membership Committee began to do active work. The results are shown in the diagram of the growth of membership by years.

At a conference in September, 1921, the plan of a Coördinated Service Council was endorsed, whereby the Committees on Research, Standards, Geological Surveys, and Data were grouped as service committees, their chairmen forming the Service Council. The duties, personnel, and proposed contacts of each committee were carefully worked out at this time and are outlined in the chart preceding.

To this has since been added a Committee on Ceramic Education whose duty it shall be to foster the existing departments of ceramics, to stimulate the founding of others, and to promote the technical education of the practical worker in the industry.

Corporation Members

It is interesting to trace the development of Corporation Membership in the SOCIETY. In 1903 a request for admission to membership was received from a firm and after careful conclave it was courteously but firmly refused. Whether this rankled in someone's thrifty soul we do not know, but in 1908 it was proposed to have a class known as Contributing Members, to which firms should be invited to belong. This was the first amendment to the rules drawn up in 1899. Because the proper end of the ball of red tape could not at first be found, action was delayed for two years. When the amendment was finally incorporated no active soliciting was begun because of the business depression of that time. The following year the need for additional funds seemed to be less acute and again no effort was made. The evident reluctance on the part of the officers to invite firms to become Contributing Members was doubtless based on the feeling that since firms as such could not attend the meetings the good to be derived would be slight and the dues paid would be so much charity. However, in 1912, five firms were listed as Contributing Members, one of whom has persisted for ten years without a lapse. The matter did not receive special attention for several more years, but in 1918 the term used was changed to Corporation Members, active solicitation was begun, and 1922 saw more than two hundred in this group.

Local Sections

Before the SOCIETY had conceived the idea of broad-casting itself, a group of ceramists at Beaver Falls, Pennsylvania, had organized the Beaver

Ceramic Society and was holding enthusiastic meetings. The New Jersey Clay Workers' Association was similarly organized and was doing united work. It was proposed in 1915 to establish local sections of the AMERICAN CERAMIC SOCIETY in different parts of the country for more frequent meetings than were possible by the national body, and to encourage especially the membership of the practical man. The group in the Beaver locality was the first to re-organize and was installed as the Beaver Section of the AMERICAN CERAMIC SOCIETY in August, 1915. Later the name was changed to the Pittsburgh District Section, in order to include a larger territory.

Other local sections followed suit and charters were applied for by Northern Ohio, Central Ohio, New England, New York State, Chicago, and St. Louis in 1918, while a year later the New Jersey Association became the Eastern Section of the AMERICAN CERAMIC SOCIETY. From time to time tentative proposals have been made for the formation of sections in the far west and in other centers.

Quarterly meetings have been held by most of the sections and they have been instrumental in producing papers for the annual meetings, in obtaining new members, and in securing expressions of public opinion on proposed changes of policy.

Student Branches

The same year that the Beaver Local Section of the SOCIETY was installed the Ohio State University Ceramic Department asked that their student society be given some status in the national SOCIETY, and Student Branches were instituted. At Ohio the branch was grafted in the spring of 1915 and the New York State School of Ceramics, at Alfred, was duly added in October. The other schools, Illinois, Rutgers, and Iowa, were not far behind, and all have flourished.

Industrial Divisions

Long before the Industrial Divisions as we know them were thought of, it was found necessary to divide the meetings into two groups, in order to cover the number of papers offered and to provide some choice for the interests which were gradually becoming diverse rather than unified. In 1909 two groups met under the chairmanship of the president and vice-president, respectively, one to discuss white ware problems, the other, heavy clay products. Nothing more definite was done until 1914 when a plan was produced calling for "permanent committees" or "topical sections," which were to be responsible for the securing of papers and discussions, to arouse the interest of others in each phase of the industry, and to arrange for a definite part of the scheduled annual program. The

"committees" suggested were six, namely, Pottery, Glass, Enameled Iron, Refractories, Structural Materials, and Cement and Lime. It is noteworthy that the divisions as fully organized in 1921 comprised practically this list with the addition of Terra Cotta and Art.

Probably delayed by the War, it was not until 1918 that the Board of Trustees took action on the method of procedure for the formation of "industrial divisions" as they were by that time known. The Enamel, Glass, Refractories, and Terra Cotta divisions were promptly established and have pursued uninterrupted programs of progress. The Heavy Clay Products and White Wares Divisions followed more slowly but began to function in 1921, while the newest addition, the Art Division, began to make itself felt in 1922. In August, 1919, the Board voted to allot 10% of the dues of the members of a division to that division for its operating expenses; the Committee on Rules drew up a model set of by-laws for the guidance of the divisions, and in every way their efforts have been encouraged. The achievements of each division cannot be enumerated here, but there is no shadow of doubt that their organization was one of the biggest bits of work ever done by the SOCIETY.

Publications

Transactions.—At the tenth annual meeting of the SOCIETY, which was of course the occasion of special celebration, the President produced, side by side, Volume I and Volume IX of the annual *Transactions*. The comparison would be ludicrous but for the fire of the pioneer blazing between the covers of the tiny book known as Volume I. This cannot be quenched by any streams of knowledge and investigation published later, and it is chiefly for this that the earlier volumes are honored. The nineteen volumes of *Transactions*, published from 1899 to 1917, form an impressive ceramic library. With the translated works of Seger, mentioned before, and the *Transactions of the English Ceramic Society* founded in 1906, they constitute practically the only technical literature on ceramics published in English during that period. Their value, historically and technically, is immeasurable.

Index.—The *Index to the Transactions* compiled under the direction of the Committee on Publications and issued in 1920 makes the set of volumes a reference work of easy access.

The Journal.—The present *Journal of the American Ceramic Society* can trace its inception back to 1905 when it was voted to publish the *Transactions* in quarterly installments. This venture was attended with indifferent success, and in 1906 a return was made to the single annual volume. The idea never quite died out, however, and in 1917 a Committee was appointed to investigate the possibilities of issuing a quarterly

or a monthly. At the meeting of 1918 it was voted to begin at once to publish a monthly journal, and Professor G. H. Brown, of Rutgers College, was made Editor. The struggle with time that the editors had is too fresh a story to need repetition, and it was not until 1922 that actual scheduled publication date was reached and adhered to. Professor Brown edited the *Journal* for two years, but was obliged to resign on account of pressure of other work. Mr. H. F. Staley, of the Bureau of Standards, succeeded him and was Editor for 1920. His resignation led to the appointment of Dr. E. W. Washburn, of the University of Illinois, who piloted the periodical through 1921, and who in turn was succeeded by Mr. R. C. Purdy, when the latter became General Secretary and Editor in 1922.

The increase in membership necessitated an annual increase in the number of copies printed in order to keep the reserve stock uniform. In 1921 the annual subscription rate was raised from six to eight dollars on account of the increased cost of printing.

The number and character of the "original" papers printed have improved steadily. In 1899, eight papers were published in Volume I, and the range of subjects was simple; in 1908 there were thirty-four papers on a diversity of subjects; while in 1922 there were one hundred and five papers published. A subject analysis of the original papers published in the first five volumes of the *Journal* shows the following figures:

TABLE I

Vol.	1	2	3	4	5
Art	1	0	3	3	9
Geology of Ceramic Materials	5	6	1	0	4
Chemical, Physical, and Physcio-Chemical	10	13	8	13	13
Enamels for Metals	7	4	5	8	6
Equipment for enameling and factory practice	0	0	1	2	7
Glass and Glass Products	8	5	8	4	4
Glass house equipment and management	2	5	7	7	5
Heavy Clay Products	1	0	2	2	6
Kilns and dryers	7	11	8	6	7
Lime, Plaster and Cements	4	2	3	3	2
Refractories, General	0	1	2	6	7
Clay	0	2	1	0	0
Silica	2	0	0	4	4
Magnesite	2	1	2	1	0
Chrome	0	0	0	0	2
Graphite	0	5	1	1	0
Special	1	0	2	1	1
Terra Cotta, Materials and Methods	3	0	5	4	7
Equipment	1	0	0	1	2
White Wares, Saggers	1	1	2	3	0
Bodies	4	9	5	4	6
Glazes	1	1	4	3	3
Methods and processes	1	2	1	0	5

Ceramic Abstracts.—Though the first number of *Ceramic Abstracts* appears in the May, 1919, number of the *Journal of the American Ceramic Society*, this too had received attention as early as 1905. A Committee on Ceramic Literature was then formed, which for a short time made notes and reviews of foreign papers on ceramic subjects. Because the work was necessarily intermittent and was being done in part by *Chemical Abstracts*, this committee was discharged and the matter was held in abeyance until the publication of the *Journal* made an abstract service possible and *Ceramic Abstracts* as a part of each number of the *Journal* was begun as soon as feasible. In the first number to contain these there were sixteen abstracts, while in December, 1922, there were one hundred and ninety-one, a mushroom-like growth, which nevertheless has stability.

The Bulletin.—There has always been more or less rivalry between the practical man and the scientific man, between whom now stands the so-called technical man. In 1909, the President of the SOCIETY made a plea for more practical papers, for as knowledge and education increased the tendency was to prepare papers of an abstruse nature, of prime interest to the student and research worker. In 1922, an effort was made to fill both sides of the scale and keep them in balance. Accordingly, the *Bulletin of the American Ceramic Society* was begun, first as a separate publication and then under the same cover with the *Journal*. This, so far as can be told in one year, has proved satisfactory, since it provides an outlet for material of less permanent value than the papers in the *Journal* but just as interesting, particularly to the practical and the technical men.

Full-time Secretary

The latest step to be taken in the development of the SOCIETY has been the appointment of a full-time Secretary. This was a question which popped up almost annually from 1908. Professor Orton for many years handled not only the Secretary's office but the editorship of the *Transactions*, single-handed and unremunerated. He frequently urged the creation of the office of paid editor, who, when expedient, should become secretary also.

It was found necessary in 1909 to begin to pay the person who edited the *Transactions*, though the amount was never commensurate with the effort.

Upon Professor Orton's resignation from the secretaryship in 1917, when he entered the army, Professor Binns, of Alfred, himself a charter member of the SOCIETY, first and only director of the New York School of Ceramics, was asked to take over the work. There was a tacit understanding at this time that it would not be long before the employment of a full-time secretary would be possible and desirable, and in 1921 a committee appointed for the purpose recommended to the Board of Trustees

that the step should then be taken. Endorsed by many of the local sections and by scores of individuals, Mr. R. C. Purdy, of Columbus, Ohio, was appointed Organizing Secretary in July, 1921, to become General Secretary in January, 1922. Permanent headquarters for the SOCIETY were then established at Lord Hall, by courtesy of the Ohio State University.

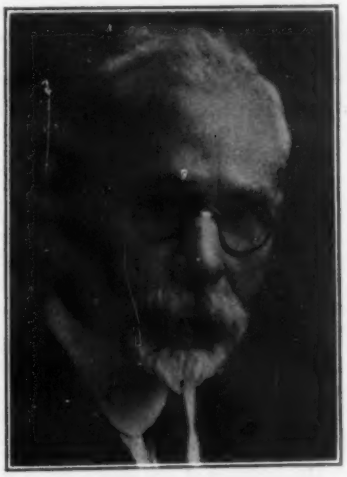
At the annual meeting in 1922, Mr. Purdy was asked to take the editorship of the *Journal*, *Abstracts*, and *Bulletin*, since it was deemed desirable to have the two offices in one for the time being.

Conclusion

The task of compiling the history of the AMERICAN CERAMIC SOCIETY has been an interesting one. These twenty-five years have seen the SOCIETY pass through the period of infancy when loving hands tended it with solicitude, through adolescence, the time of physical growth and keen enthusiasms, to manhood. When the SOCIETY "came of age" four years ago, there seemed to be a buckling on of armor for sturdier crusading than ever before. There was a determination to render service, to pull together previously conflicting or overlapping interests, and to show real leadership. Since its twenty-first birthday the SOCIETY has redoubled its efforts for efficiency and coöperation, and although it cannot be said that the aim has been reached, else the limit had not been nearly high enough, yet certain sure strides have been taken and the goal is nearer and clearer.

CHARTER MEMBERS

Charles Fergus Binns



CHAS. F. BINNS

Charles F. Binns, director of the New York State School of Clay Working and Ceramics at Alfred, New York, since its founding, was born in Worcester, England, in 1857. Mr. Binns entered the Cathedral King's School in his native city and began the usual classical education of an English boy. At the early age of fourteen he was withdrawn from school and was taken as an apprentice at the Royal Worcester Porcelain Works. At that time chemistry was not taught in the city, so arrangements were made for him to visit the neighboring city of Birmingham in order to study this subject. Following upon this a laboratory was equipped at the manufactory and some attempt was made at chemical control of operations. For a number of years Prof. Binns resided in London in charge of the city sales agency and at this time lectured before the Society of Arts and other organizations. In 1897 Professor Binns came to the United States and located at the newly-formed School of Applied Art in Trenton, New Jersey. For two years he worked in the laboratory of the School by day and taught at the Art School

in the evening. In 1900 when the New York State School of Ceramics was to be established, the President of Alfred University and Mr. Charles T. Harris visited Trenton and an interview took place which resulted in the appointment of Mr. Binns to the directorate of the school. In recognition of his work Alfred University gave him the honorary degree of Master of Science in 1901.

The call issued in 1898 for the formation of the AMERICAN CERAMIC SOCIETY found a ready response in Mr. Binns and he became a charter member of the SOCIETY. At the first meeting in 1899 he was elected Trustee, the following year he was made Vice-President and in 1901 he was chosen President. In 1918, when Professor Orton's resignation necessitated the choice of a new Secretary for the SOCIETY, Professor Binns was asked to take the position which he filled for four years. Prof. Binns is a member of the English Ceramic Society and of various art organizations and is a Master Craftsman in the Boston Society of Arts and Crafts. He is the author of numerous papers which have appeared in the *Transactions* and the *Journal of the American Ceramic Society* and in other publications and also of two books on the potter and his craft.

Albert V. Bleininger

Albert V. Bleininger was born in Polling, Bavaria, in 1873. From 1889 to 1896 he worked in the clay industry receiving shop experience and in 1897 he completed a short course in Ceramics at Ohio State University. His Bachelor of Science degree in chemistry was received from this Institution in 1901. For four years, from 1898 to 1901, Mr. Bleininger acted as laboratory assistant in ceramics and until 1907 was instructor, assistant and associate professor at Ohio State University. He served as assistant to the Ohio Geological Survey from 1900 to 1904.

A. V. BLEININGER

In 1907 Mr. Bleininger went to the University of Illinois where he was assistant professor in Ceramics. During the years 1908 to 1910 he was in charge of the clay products section of the United States Geological Survey. In 1910 he returned to the ceramics department of the University of Illinois as professor and director of the department. This position he retained until 1912 when he accepted an appointment by the Bureau of Standards as section and division chief. In 1920 Mr. Bleininger left the Bureau of Standards to become chemist for the Homer-Laughlin China Co., in Newell, West Virginia.

One of the most valuable contributions made by Mr. Bleininger to the ceramics world was his translation of the complete writings of Seger. He has also contributed liberally to the literature of ceramics with writings for the *Transactions of the American Ceramic Society* and other technical journals.

Mr. Bleininger is a charter member of the AMERICAN CERAMIC SOCIETY and acted as President 1908–1909. At present he is serving as Chairman of the Technical Committee of Joint Research of the four heavy clay products associations.

Stanley G. Burt

Stanley G. Burt was born in Cincinnati, Ohio, in 1870. He was graduated from Yale University in 1892, and one month later went to work at the Rookwood Pottery

Company of Cincinnati. In 1894, he was absent for one year while he studied the chemistry of pottery in Berlin. Returning the next year to Rookwood, he took charge of the Chemical Department, and in 1898 became Superintendent of the Company.

Mr. Burt served as Treasurer of the AMERICAN CERAMIC SOCIETY from its organization in 1899 until 1905–1906, and during 1907–1908 was President of the SOCIETY.

STANLEY G. BURT

J. Parker B. Fiske

J. Parker B. Fiske, President, Domestic Oil Heating Co., Boston, Mass., was born October 8, 1865, at Medfield, Mass. He studied mechanical and electrical engineering at the Massachusetts Institute of Technology of Boston, graduating therefrom with the degree of S.B.

His first position was with the Thompson-Houston Electrical Company, of Lynn, Mass., from 1889 until 1896, when he went into partnership with his father at Boston, Mass., in Fiske & Co., Inc., manufacturers of burned clay products. In 1918 he went with the Marlin-Rockwell Corporation as General Manager of its Standard Roller Bearing Department at Philadelphia. Later he accepted the position of President and General Manager of the Sunnyhome Electric Company of Detroit, Mich. (a Division of the General Motors Corporation), manufacturers of farm lighting and power plants, and in July, 1919, he had added to these duties the Presidency and General Management of the Frigidaire Corporation, another Division of the General Motors Corporation, the latter concern manufacturing iceless electric refrigerators.

J. PARKER B. FISKE

Mr. Fiske has made many inventions in the electrical and clay working field, as well as in farm lighting and refrigerating apparatus, and has taken out about fifty patents. "Tapestry" brick was created and introduced by Mr. Fiske about ten years ago.

Mr. Fiske was the originator of the Building Brick Association of America and one of the leading organizers of the American Face Brick Association and other coöperative societies for the promotion of trade coöperation.

He is a charter member of the AMERICAN CERAMIC SOCIETY and a member of the Engineers' Club of New York, American Society of Automotive Engineers, American Society of Refrigerating Engineers and Technology Club of New York.

W. D. Gates

W. D. Gates was born at Ashland, Ohio, in 1852. He was graduated from Wheaton College in 1875, and was admitted to the Illinois Bar in 1879.

For a short while, he practised law in Chicago, but he soon became interested in clay, and started manufacture at Terra Cotta, McHenry County, Illinois, establishing

the station there and originating the American Terra Cotta & Ceramic Company. This Company was incorporated in 1887.

Mr. Gates is a charter member of the AMERICAN CERAMIC SOCIETY, and at the time of the organization of the SOCIETY, acted as temporary chairman. He served as President of the SOCIETY in 1905. He was President of the National Brick Manufacturers' Association in 1900, and of the National Terra Cotta Society in 1920.

WM. D. GATES

Samuel Geijsbeek

Samuel Geijsbeek of Seattle, Washington, was born in Holland, and received his technical education at the Royal German Technical University, Berlin-Charlottenberg, and at the Ohio State University, Columbus, Ohio. He was graduated from the latter institution in 1896. Mr. Geijsbeek's grandfather was one of the foremost roofing tile manufacturers in Holland.

For several years, Mr. Geijsbeek was connected with the Winkle Terra Cotta Company of St. Louis. At Golden, Colorado, in 1900, he made the first white table ware from native clays to be manufactured west of the Mississippi. In 1906, Mr. Geijsbeek, removed to the Pacific Northwest, where he organized the Northern Clay Company at Auburn, Washington, for the manufacturing of Terra Cotta. In 1910, his connection with this Company was severed, and he opened an engineering office under the name of the Geijsbeek Engineering Company, making a specialty of clay works engineering in the Pacific Northwest states.

SAMUEL GEIJSBEEK

Mr. Geijsbeek is a charter member of the AMERICAN CERAMIC SOCIETY, and served as Vice-President of the SOCIETY during 1906–1907. He is also a member of the National Brickmakers' Association, is a licensed practicing engineer in the State of Oregon, and for seven years has acted as Secretary and Treasurer of the Oregon Clayworkers' Association. Mr. Geijsbeek has contributed various papers to the *Transactions of the American Ceramic Society*, and also to leading clay journals.

E. E. Gorton

E. E. Gorton attended the Ohio State University and spent four years with the American Terra Cotta and Ceramic Company and then did special work in the ceramic line in various parts of the United States for two years. He later located in New York where he was Treasurer and Manager of the W. A. Underhill Brick Company. Mr. Gorton is now in the oil business.

Mr. Gorton was a charter member of the AMERICAN CERAMIC SOCIETY and with Mr. Wheeler asisted in drawing up the By-Laws and Constitution of the SOCIETY. His recent years have not been connected with the ceramic business.

Karl Langenbeck

Karl Langenbeck was born in Cincinnati, Ohio, on October 7, 1861. He was graduated from the College of Pharmacy in Cincinnati in 1882 and attended laboratory classes and lectures on chemistry at the University of Cincinnati. He later attended the Federal Polytechnic School in Zürich, Switzerland and the Kgl. Technische Hochschule in Berlin.

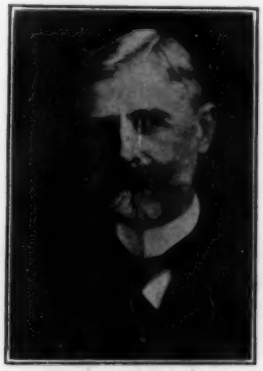
ELMER E. GORTON

In 1885 and1886 Mr. Langenbeck was chemist and superintendent of the Rookwood Pottery in Cincinnati. His experiments at this time led to the discovery of conditions of crystalline separation of ferric chromate from ferric-lead glazes in aventurine-like formation called Rookwood "Tiger eye" ware.

Mr. Langenbeck promoted the Avon Pottery in Cincinnati and opened ball clay deposits of Western Kentucky for commercial use at the instance of the Kentucky Geological Survey. Samples made from this clay in 1887 are now in the museum at Frankfort, Kentucky.

During 1888 and 1889 Mr. Langenbeck did chemical laboratory work, serving as Chemist to the City Health Officer and was also Professor of Chemistry in Miami Medical College.

From 1890 until 1893 he was chemist for the American Encaustic Tiling Company of Zanesville, Ohio, where he introduced parian vitreous bodies to take the place of "smeared" white and light colored tile used exclusively in American and English manufacture until then. Dust inlaid encaustic tile and Seger's cones for firing control were introduced. The Mosaic Tile Company of Zanesville, Ohio, was also promoted by Mr. Langenbeck.



KARL LANGENBECK

In his research work, Mr. Langenbeck discovered the zinc oxide-feldspar glaze and introduced its use for stoneware. He also applied mechanical analysis to molding sands and started the "milled sand" industry of the country. He organized better technical, commercial and decorative methods in numerous factories and made a study of the causes of decay in wood floors. He popularized the hygenic importance of tiling for the tile industry. Other phases of his work were physiological studies in the rhythm of nutrition and oxidation and studies in soil chemistry for fertilizer industries. Among his writings is the "Chemistry of Pottery."

Mr. Langenbeck is at the present time with the United States Tariff Commission. He served as President of the AMERICAN CERAMIC SOCIETY during 1900–1901.

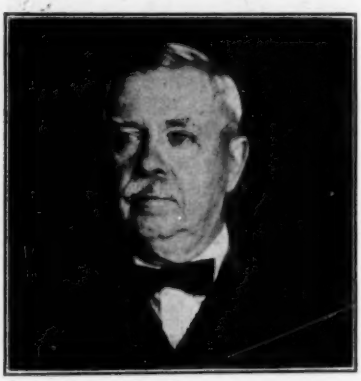
Ellis Lovejoy

Ellis Lovejoy was born in Columbus, Ohio, in 1860. His early education was received in country and village schools and from 1875 to 1877 he attended normal school. For three years following this Mr. Lovejoy taught country school and in the spring

of 1879 matriculated in Ohio State University. His degree in Mining Engineering was received in 1885. During the years 1883 and 1885–1886 he served as assistant in the field work of the Ohio Geological Survey.

In 1886–1887 Mr. Lovejoy was chemist for the Columbus Brick and Terra Cotta Company, Union Furnace, Ohio, and was superintendent of this company until 1907. This Company had a compartment continuous kiln, the first to be built in Ohio and as far as is known the third to be used in the United States. The equipment consisted of dry press brick machines, the first to be introduced in Ohio and east of St. Louis.

The products of this kiln were fire bricks using local plastic fire clay, flint clays from Olive Hill, Kentucky, and from Vinton County, Ohio. A fine sand product was also in use which was made from a sand rock formerly quarried and widely used in charcoal iron furnace hearths. These products manufactured in 1886–1887 were the first dry pressed fire brick products to be made in the county.



ELLIS LOVEJOY

This plastic fire brick product was then made into a face building brick of light buff shade used for the first time in a residence, and other shades of buff and a color designated as terra cotta was produced.

One of the problems widely discussed was the cause of efflorescence on walls and when this fault was overcome the Union Furnace product was given a decided advantage in the market.

The progenitor of the recent pulsichrome product was developed in a red brick with black splotches. This together with a white enameled brick was worked out under the immediate supervision of a student from Professor Orton's school of ceramics.

In 1903–1904, Mr. Lovejoy was manager of the Imperial Clay Company of New Lexington, Ohio. The first wire-cut texture face brick were produced here which opened a wider field in face brick than any previous development.

The years 1904–1906 were spent as consulting engineer and from that time until 1916 Mr. Lovejoy was treasurer and subsequently president of the Richardson-Lovejoy Engineering Company. This Corporation was dissolved and its charter surrendered in 1916 and since that date Mr. Lovejoy has been employed in consulting work.

Mr. Lovejoy is the author of "Scumming and Efflorescence," "Drying Clay Wares," and "Burning Clay Wares."

He served as President of the AMERICAN CERAMIC SOCIETY during 1913–1914 and was Treasurer of the SOCIETY from 1906–1913 and is also a charter member. Since 1886 he has been a member of the American Institute of Mining and Metallurgical Engineers.

Ernest Mayer[1]

Ernest Mayer was born in Burslem, Staffordshire, England, October 4, 1857, the son of Jos. Mayer of the pottery firm of T. J. and J. Mayer, Dale Hall Works, Burslem. His father, Jos. Mayer, was known in his time as an expert in the manufacture of pottery, and frequently referred to as the successor of Josiah Wedgwood as an authority on the subject.

[1] Died Dec. 13, 1920.

Ernest Mayer's first connection with the Pottery Industry was in the capacity of an apprentice with the firm of G. W. Turner & Sons, Tunstall, England, where about the same time Mr. W. H. Grindley, the well-known Staffordshire manufacturer was similarly beginning his career. Later he was connected with the firm of Clemenston Brothers, Hanley, England. He first attracted some notice in the trade by the publication of a pamphlet on an improved method of mixing bodies wet. He was also about this time the originator of a new kind of Jigger. Mr. Mayer came to America in 1878 and spent a year in the office of his two brothers, then engaged in the business of importing crockery in New York City and then became superintendent for a time of a pottery in Baltimore.

ERNEST MAYER

In 1881, together with his brother Joseph Mayer, he established what is known today as the Mayer China Company at Beaver Falls, Pa., one of the best known producers of hotel china in this country, and for the past forty years he had been actively in charge of the manufacturing end of that business.

As master of all the complicated details of pottery manufactory, and particularly in the chemistry of pottery, perhaps no man living today excelled him. His abilities were recognized among manufacturing potters, universally, not only in this country but in England as well, and his counsel and advice will be greatly missed by all his associates in the trade.

High above his knowledge and skill in his chosen art, however, Ernest Mayer will be appraised and remembered for his character as a man. Totally without pretense, unassuming, even backward, he yet possessed a strong personality that impressed, and had the courage to always stand by his convictions.

Mr. Mayer was a charter member of the AMERICAN CERAMIC SOCIETY and was elected Vice-President the first year of the organization. He was Vice-President again in 1901–1902 and served as President in 1902–1903.

H. C. Mueller

H. C. Mueller was born in 1854 at Rodach, near Saxe-Coburg, Germany. In his early years he studied as a sculptor in Nuremburg and Munich, modeling and carving wood and stone. After leaving the art schools he traveled, working in his profession as a sculptor. He served for two years in the German Army and shortly afterward immigrated to America and located in Cincinnati where he worked at carving marble, lithographing, modeling and later in cement work. During this period Mr. Mueller made models for the Kensington Tile Works and also for the Matt Morgan Art Pottery. He later modeled at the Brighton Terra Cotta Factory in Indianapolis and when the State Capitol of that State was being erected he was engaged to make models for the statuary of the façade of the building and other decorative features in the pediments and gables. He also carved and made models for the interior

H. C. MUELLER

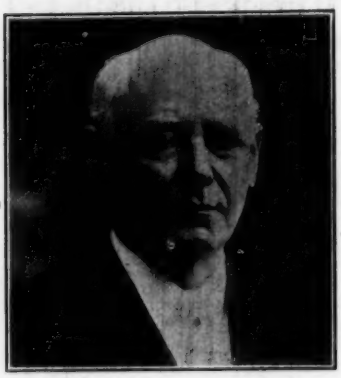
stucco work. Following this period he was employed by the United States Encaustic Tiling Company making designs and models for mantel facings and for ten years worked with the American Encaustic Tiling Company. During this period he also engaged in mechanic technical work, inventing processes of inlaying mosaics for which he received a John Scott medal of the Franklin Institute of Philadelphia. With Mr. Karl Langenbeck he organized the Mosaic Tile Company of Zanesville, Ohio, and after seven years took over the management of the National Tile Company. He also worked for six years with the Robertson Art Tile Company of Morrisville, Pa. Mr. Mueller later organized the Mueller Mosaic Company of Trenton, N. J., in which he continues principally in original artistic work.

Mr. Mueller was a charter member of the AMERICAN CERAMIC SOCIETY.

Edward Orton, Jr.

Edward Orton, Jr., was born in 1863, of New England and New York lineage. His people were farmers with a good sprinkling of educators, clergy and professional men. His father was the first President of the Ohio State University. Edward, Jr. was graduated from that school in 1884 as a Mining Engineer, and began his professional work as a surveyor in the coal mines.

After a few months of this, he entered the metallurgical field, serving as draftsman in steel works, chemist in blast furnaces and open hearth steel works, finally becoming superintendent of blast furnaces in Ohio and Virginia. In this latter capacity, he was the first in the United States (1888) to produce ferrosilicon, or iron alloys containing guaranteed high percentages of silicon.



COL. EDWARD ORTON, JR.

In 1890, he left the metallurgical field, to enter clay manufacture, serving as superintendent of paving brick plants in Ohio and Kentucky, and as special contributor on clays and manufacture of clay products for the Ohio Geological Survey. In 1893 he agitated the founding of a technical school for the study of clays and clayworking upon a scientific and engineering basis, and in 1894 succeeded in inducing the Legislature of Ohio to establish such a school, the first of its kind in the United States, in the Ohio State University. He became the first Director and remained the guiding genius of the school for twenty-two years (1916).

As a writer and research man in the ceramic field, Professor Orton has a goodly list of articles and investigations to his credit. He has been of possibly greater value in inspiring and directing the researches and publications of others, for which he cannot of course be given credit in his own bibliography.

The idea of putting clayworking and ceramic operations in general upon a scientific basis, comparable in accuracy to those of metallurgy, under the title of Ceramic Engineering, was accepted slowly and reluctantly by the industries concerned, and also by the technical and engineering schools. Professor Orton has had the satisfaction of seeing his idea take firm root, and become an accepted branch of engineering training in a number of strong universities in the United States and in England.

He was the promoter and active spirit in organizing in 1898 the AMERICAN CERAMIC SOCIETY, which has become the internationally known exponent of the Ceramic Engineering profession. He served as Secretary of this organization for twenty years, until 1918, and as editor of its first ten volumes of the *Transactions*.

In 1896 he began the manufacture upon a small scale of Standard Pyrometric cones, a device for regulating and controlling the firing process in kilns and industrial furnaces. This business grew steadily until a factory had to be erected in 1906 to take care of it. Professor Orton has owned, supervised and managed this business ever since its inception, without conflict with his educational and professional duties, and for some years it has been his chief financial dependence.

In 1899, upon the death of his father, Dr. Edward Orton, he succeeded him as State Geologist of Ohio, which position he filled until 1907. During his administration he reorganized the Survey, and issued two volumes and nine bulletins of reports, mostly upon economic geology.

In 1902, Professor Orton was made Dean of the College of Engineering, of the Ohio State University, and held this position with brief intermission until 1916.

For many years an ardent believer in the importance of military training, and foreseeing the part that the United States would play in the World War, Dean Orton took the training in 1916 in the Citizen's Military Training camp at Plattsburgh, New York, and was commissioned a Major in the Quartermasters Reserve Corps in January, 1917. Upon the opening of hostilities in April, 1917, he was ordered into active duty and assigned to the Motor Transport branch. He was promoted to Lieutenant Colonel in September, 1918. For his exceptionally meritorious services in the standardization of motor equipment he was awarded the Distinguished Service Medal. He was discharged in June, 1919, and at once re-commissioned as a Colonel of the Officers Reserve Corps.

Returning to Columbus in 1919, Colonel Orton did not go back into educational work, but resumed supervision of his manufacturing business. In addition he bought and operated a farm, and afterwards soon began devoting his spare time to various forms of public service for the Chamber of Commerce and other organizations.

He was elected President of the Columbus Chamber of Commerce in 1921, and again in 1922. Under his administration the Chamber has enjoyed a period of vigorous constructive work and excellent material progress upon numerous public projects has been made.

Colonel Orton believes firmly in the engineering education, with its inflexible curriculum and its merciless insistence upon reasoning only from demonstrable facts of science, as the best foundation for the development of mental power, no matter what profession may be the ultimate goal.

JAMES PASS

James Pass[1]

James Pass was born in Burslem, Staffordshire, England, in 1856, and came to this country with his parents in 1863. At the age of thirteen he was apprenticed to a pottery maker at Trenton, N. J., and later when the family removed to Syracuse, N. Y., he became foreman under his father at the Onondaga Pottery. After three years spent in the West he returned to the Onondaga Pottery as General Manager. Mr. Pass's appreciation of the value of the application of scientific methods in the ceramic industries was evidenced by his attendance as a student for a year at Syracuse University where he took a special course in Chemistry.

Mr. Pass was a charter member of the AMERICAN CERAMIC SOCIETY and he also belonged to other technical organizations.

[1] Died October, 1913.

Willard Durant Richardson

W. D. Richardson was born in Georgetown, N. Y., August 28, 1857. He was graduated from Colgate University in 1879 with a degree of A.B. and in 1884 received the degree of A.M. from the same Institution. Following his graduation at Colgate, Mr. Richardson was Principal of the High School, Chattanooga, Tenn., and later while taking a course in mining engineering at Columbia University he taught in the public evening schools of Brooklyn. After leaving Columbia he worked as an analytical chemist in the laboratory of Dr. Sloane where he first became interested in clays. Later, while teaching in Minneapolis he spent three summers in dry-press brick plants at Coon Creek, Monticello and Rush City.

In 1888 Mr. Richardson came to Ohio from St. Louis for the purpose of building a face brick plant at North Baltimore which he had charge of for five years. He was later General Manager of brick companies at Cleveland and Shawnee, Ohio and Hebron, North Dakota, making face brick, paving brick and hollow building tile. After this for five years he was alone in Columbus at the head of his own brick works engineering business and for five years he was associated with Mr. Ellis Lovejoy and the Richardson-Lovejoy Engineering Company. During the War Mr. Richardson acted as ceramic engineer for the Shipping Board of the United States and following the signing of the Armistice he established the Ceramic Engineering Company in Columbus of which he is President.

W. D. RICHARDSON

Mr. Richardson has published numerous articles and pamphlets on brick manufacture and has taken out several patents on improved equipment for the clay industries. The best known among these latter is the "Richardson Continuous Compartment Kiln Fired with Producer Gas."

Mr. Richardson was President of the AMERICAN CERAMIC SOCIETY, 1906–1907, and was a charter member. He is also a member of the National Brick Makers' Association and the English Ceramic Society, being a past President of the former Association. He is a member of the Committee on Technical Investigations of the National Brick Makers' Association and AMERICAN CERAMIC SOCIETY Representative on the American Society for Testing Materials Committee D-14.

H. Ries

H. Ries, Professor of Geology and Head of the Department of Geology, Cornell University, Ithaca, N. Y., was born in Brooklyn, N. Y., April 30, 1871. He was graduated from Columbia University with the degrees of Ph.B. in 1892, M.A. in 1894 and Ph.D. in 1896. From 1893 to 1895, Dr. Ries held a University Fellowship at Columbia University and from 1897 to 1900 held the Barnard Fellowship from the same Institution. The work under the latter Fellowship was done for the special purpose of investigating the geology and properties of clay. While thus engaged he spent a year in Europe studying the foreign clay deposits and working with Prof. Witt of Berlin.

Ever since his graduation Dr. Ries has been especially interested in the subject of the geology of clay and its uses.

In addition to being the author of numerous papers on this subject he has prepared special reports for State Geological Surveys on the clays of Alabama, New York,

Maryland, Virginia, Florida, Louisiana, Michigan, North Carolina, Texas and New Jersey. He has written several reports on the same subject issued by the U. S. Geological Survey, the last one of these on the "High Grade Clays of the United States," being prepared during the War in connection with the War Minerals Work carried on by the Government. Other writings of Dr. Ries are "Clay, its Occurrence, Properties and Uses," "Economic Geology," and (with H. Laighton) "History of the Clay Working Industry of the United States." The latter was prepared under the auspices of Carnegie Institute. Dr. Ries was also engaged by the Canada Geological Survey to investigate the clay resources of Canada, the results of which were embodied in several reports.

H. RIES

Dr. Ries is Chairman of the Non-Metallic Minerals Committee of the American Institute of Mining and Metallurgical Engineers. He is a charter member of the AMERICAN CERAMIC SOCIETY, English Ceramic Society, American Institute of Mining Engineers, Canadian Mining Institute, and the Geological Society of America. During 1910 and 1911 Dr. Ries was President of the AMERICAN CERAMIC SOCIETY. He is a member of the Executive Committee of Committee in charge of Ivestigation of Molding Sands, acting under the National Research Council and American Foundrymen's Association.

Edward C. Stover

Edward C. Stover for the past twenty-four years has been Treasurer of the School of Industrial Arts at Trenton, N. J. He is a charter member of the AMERICAN CERAMIC SOCIETY, and served as President during 1903–1904. Mr. Stover is also a charter member of the Society Ceramique of France, and also of the English Ceramic Society of the Staffordshire pottery district of England. He acted as chairman of the publication committee of the works of Herman Seger.

EDWARD C. STOVER

Francis William Walker

Francis W. Walker was born at Industry, Pa., on May 7, 1855. After completing his general education at the Kenwood School at New Brighton, Pa., he studied pharmacy first at the Maryland College of Pharmacy, Baltimore, and later at the Pittsburgh College of Pharmacy (now the University of Pittsburgh), where he finished his professional education and was graduated with the degree of Ph.G. in 1882. Early in the following year he established himself as a pharmacist in New Brighton and followed his profession until 1887.

In 1886, Mr. Walker organized the Beaver Falls Art Tile Company, at Beaver Falls, Pa., built a plant and began operations in 1887, and acted as its General Manager

until 1916, when he relinquished this position to his son. He served also as the Secretary-Treasurer of this company from its beginning until 1920, when he was made President.

F. W. WALKER

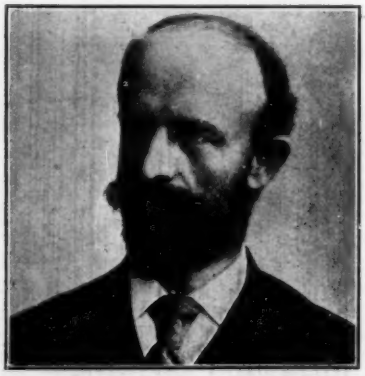
In 1893 he organized the first association of tile manufacturers, and served as its Secretary for a number of years. Mr. Walker is now the Executive Secretary of the Associated Tile Manufacturers and the Tile Manufacturers' Credit Association, a position which he has held since 1903.

He is also President of the Robert Rossman Company of New York, a tile jobbing and importing house; the Vice-President of the American Vitrified Products Company, and Vice-President of the Pennsylvania State Chamber of Commerce.

Mr. Walker is an active member of the AMERICAN CERAMIC SOCIETY, being one of its organizers and served as its sixth President during 1904–1905. He was also Vice-President, 1902–1903.

H. A. Wheeler

H. A. Wheeler was born in Brooklyn, N. Y., in 1859, and was graduated in 1880 as a mining engineer from Columbia University. Following his graduation, he spent one year in Utah on the United States Geological Survey, one year on location work in Utah and Colorado for the Denver, Rio Grande and Western Railroad, and a third year in charge of the Ely Copper Mine, at Ely, Vermont. He then joined the Mining Department of Washington University, St. Louis, Missouri, where for twelve years he had charge of the Department of Mining and Geology. Since 1893, he has been in consulting practice as ceramist and mining engineer in St. Louis.



H. A. WHEELER

While at Washington University, Mr. Wheeler undertook the field and physical study of the clays of Missouri for the Missouri Geological Survey, which material was subsequently published as Volume II of the Missouri Survey Reports. In 1897, he built and operated the plant of the Standard Tile Company, the first roofing tile plant west of the Mississippi. Mr. Wheeler has made frequent contributions to the technical press. Although from 1895 to 1910, he was quite active as a consulting ceramist, his recent years have been devoted to mining engineering and the geology of oil.

Mr. Wheeler served the AMERICAN CERAMIC SOCIETY as its first President and took a very active part in its affairs and earlier history. More recently, the demands of other interests have prevented his participating in the active affairs of the SOCIETY.

Werner Hermann Zimmer

W. H. Zimmer was born at Gera, Turingen, Germany in 1857. He studied at the Universities of Jena and Berlin from 1885 until 1890 and passed, *cum laude*, his exami-

nation as Doctor of Philosophy at Berlin where he remained as Assistant in the first laboratory of chemistry of the University. In 1891 he applied himself to ceramics and studied at the Versuchsanstalt of the Royal Porcelain Works, Charlottenburg. In the same year he left for the United States to become Superintendent and later Manager of the Ohio Valley China Company, Wheeling, W. Va. After this Company closed down he became connected with the Wheeling Potteries where he remained until 1901. At this time he returned to Germany to become Editor of the *Sprechsaal* in Coburg. During this Coburg period he was also technical advisor for the Annawerk near Coburg where he established the manufacturing of sanitary ware. Since July, 1907, Dr. Zimmer has been connected with the Havilands of New York and Limoges. After visiting Limoges he built the factory Johann Haviland in Waldershof, Bavaria, for the manufacturing of porcelain dinner- and hotel-ware. Since that time Dr. Zimmer has remained in Waldershof although his family resides in this country.

W. H. ZIMMER

Dr. Zimmer was a charter member of the SOCIETY.

OFFICERS OF THE AMERICAN CERAMIC SOCIETY FROM 1899–1922

1899–1900

		Council
President,	H. A. Wheeler	H. A. Wheeler, E. Mayer, E. Orton, Jr., S. G. Burt, W. H. Zimmer, S. Geijsbeek, C. F. Binns
Vice-Pres.,	Ernest Mayer	
Secretary,	Edward Orton, Jr.	
Treasurer,	Stanley G. Burt	

1900–1901

		Council
President,	Karl Langenbeck	K. Langenbeck, C. F. Binns, E. Orton, Jr., S. G. Burt, S. Geijsbeek, W. H. Zimmer, H. A. Wheeler
Vice-Pres.,	C. F. Binns	
Secretary,	Edward Orton, Jr.	
Treasurer,	Stanley G. Burt	

1901–1902

		Council
President,	C. F. Binns	C. F. Binns, E. Mayer, E. Orton, Jr., S. G. Burt, S. Geijsbeek, H. A. Wheeler, A. V. Bleininger
Vice-Pres.,	E. Mayer	
Secretary,	Edward Orton, Jr.	
Treasurer,	Stanley G. Burt	

1902–1903

		Council
President,	Ernest Mayer	E. Mayer, F. W. Walker, E. Orton, Jr., S. G. Burt, H. A. Wheeler, A. V. Bleininger, A. F. Hottinger
Vice-Pres.,	F. W. Walker	
Secretary,	Edward Orton, Jr.	
Treasurer,	Stanley G. Burt	

1903–1904

President, E. C. Stover
Vice-Pres., H. Ries
Secretary, Edward Orton, Jr.
Treasurer, Stanley G. Burt

Council
E. C. Stover, H. Ries, E. Orton, Jr., S. G. Burt, A. V. Bleininger, E. E. Gorton, A. F. Hottinger

1904–1905

President, F. W. Walker
Vice-Pres., A. V. Bleininger
Secretary, Edward Orton, Jr.
Treasurer, Stanley G. Burt

Council
F. W. Walker, A. V. Bleininger, E. Orton, Jr., S. G. Burt, A. F. Hottinger, E. E. Gorton, E. C. Stover

1905–1906

President, W. D. Gates
Vice-Pres., Ellis Lovejoy
Secretary, Edward Orton, Jr.
Treasurer, Stanley G. Burt

Trustees
E. E. Gorton, E. C. Stover, W. M. Fickes

1906–1907

President, W. D. Richardson
Vice-Pres., S. Geijsbeek
Secretary, Edward Orton, Jr.
Treasurer, Ellis Lovejoy

Trustees
E. C. Stover, W. M. Fickes, A. S. Watts

1907–1908

President, S. G. Burt
Vice-Pres., R. C. Purdy
Secretary, Edward Orton, Jr.
Treasurer, Ellis Lovejoy

Trustees
W. M. Fickes, A. S. Watts, L. Parker

1908–1909

President, A. V. Bleininger
Vice-Pres., Chas. Weelans
Secretary, Edward Orton, Jr.
Treasurer, E. Lovejoy

Trustees
A. S. Watts, L. Parker, C. W. Parmelee

1909–1910

President, Ross C. Purdy
Vice-Pres., Arthur S. Watts
Secretary, Edward Orton, Jr.
Treasurer, Ellis Lovejoy

Trustees
L. Parker, C. W. Parmelee, H. E. Ashley

1910–1911

President, H. Ries
Vice-Pres., R. R. Hice
Secretary, Edward Orton, Jr.
Treasurer, Ellis Lovejoy

Trustees
C. W. Parmelee, H. E. Ashley, W. J. Cannan

1911–1912

President, Charles Weelans
Vice-Pres., L. E. Barringer
Secretary, Edward Orton, Jr.
Treasurer, Ellis Lovejoy

Trustees
H. E. Ashley, (E. Mayer, served Ashley's unexpired term), W. J. Cannan, J. P. B. Fiske

1912–1913

President, Arthur S. Watts
Vice-Pres., C. W. Parmelee
Secretary, Edward Orton, Jr.
Treasurer, Ellis Lovejoy

Trustees
W. J. Cannan, J. P. B. Fiske, H. P. Humphrey

1913–1914

President, Ellis Lovejoy
Vice-Pres., Adolph F. Hottinger
Secretary, Edward Orton, Jr.
Treasurer, Herford Hope

Trustees
J. P. B. Fiske, H. P. Humphrey, F. W. Walker

1914–1915

President, C. W. Parmelee
Vice-Pres., D. T. Farnham
Secretary, Edward Orton, Jr.
Treasurer, Herford Hope

Trustees
H. P. Humphrey, F. W. Walker, G. H. Brown

1915–1916

President, R. R. Hice
Vice-Pres., R. T. Stull
Secretary, Edward Orton, Jr.
Treasurer, Herford Hope

Trustees
F. W. Walker, G. H. Brown, H. F. Staley

1916–1917

President, L. E. Barringer
Vice-Pres., F. K. Pence
Secretary, Edward Orton, Jr.
Treasurer, Herford Hope

Trustees
G. H. Brown, H. F. Staley, A. F. Hottinger

1917–1918

President, G. H. Brown
Vice-Pres., Charles E. Jackson
Secretary, Edward Orton, Jr.
Treasurer, Ralph K. Hursh

Trustees
E. T. Montgomery, H. F. Staley, A. F. Hottinger, L. E. Barringer

1918–1919

President, H. F. Staley
Vice-Pres., A. F. Greaves-Walker
Secretary, C. F. Binns
Treasurer, R. K. Hursh

Trustees
E. T. Montgomery, R. D. Landrum, A. F. Hottinger, G. H. Brown, L. E. Barringer

1919–1920

President, R. T. Stull
Vice-Pres., R. H. Minton
Secretary, C. F. Binns
Treasurer, R. K. Hursh

Trustees
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Secretary,	C. F. Binns	R. M. Howe, R. T. Stull,
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1922–1923

President,	F. H. Riddle	Trustees
Vice-Pres.,	E. Ward Tillotson, Jr.	F. B. Ortman, R. M. Howe,
Secretary,	Ross C. Purdy	B. E. Salisbury, R. H. Minton,
Treasurer,	Ralph K. Hursh	F. K. Pence

PAST AND PRESENT OFFICERS[1]

Ross C. Purdy

Ross C. Purdy was born in Jasper, New York, in 1875, and took his degree of Ceramic Engineer in 1908 at the Ohio State University. From 1899 until 1901, he was chemist and assistant superintendent of the Mosaic Tile Company, and for a year was chemist and foreman of the glazing and burning departments of the Roseville Pottery Company. For three years, Mr. Purdy was Assistant in Ceramics at the Ohio State University, and from 1905 until 1907, he was instructor at the University of Illinois, where he organized the Department of Ceramics. During 1907–1908 he was Assistant Professor of Clay Working and Ceramics at Ohio State University and in 1909 was Associate Professor of Ceramic Engineering, and from 1909 until 1911, Professor of the same Department. From 1911 until 1919, Mr. Purdy was director of the research laboratories of Norton Company, Worcester, Massachusetts. Since 1919, he has been Vice-President and Assistant General Manager of the Dover Manufacturing Company at Dover, Ohio. From 1905 until 1907, Mr. Purdy was also ceramist for the Illinois Geological Survey. In July, 1921, he was made Organizing Secretary of the AMERICAN CERAMIC SOCIETY, with offices located at the Ohio State University, Columbus, Ohio.

ROSS C. PURDY

During 1909–1910, Mr. Purdy was President of the AMERICAN CERAMIC SOCIETY, and in 1907–1908 was Vice-President. He was Chairman of the Membership Committee during 1916, 1917 and 1918, and Editor of Vol. 13 of the *Transactions* in 1911.

In February, 1922, he was appointed editor of this *Journal*, which was enlarged, and the new *Bulletin* section with Discussions and Activities of the Society added.

Other organizations to which Mr. Purdy is allied are Sigma Xi and the American Society for Testing Materials, in which Society he serves on the Advisory Council, and also as Chairman of Committee C-8.

Charles Weelans[2]

Charles Weelans was born in Barnaby, Yorkshire, England in 1863 and came with his parents to Trenton, N. J., while an infant. At the age of fifteen he was employed

[1] Other than those who are also charter members.

[2] Died Dec. 12, 1916.

in a pottery and at the age of twenty-five was made superintendent of the Upper Greenwood Pottery. He subsequently was connected with the Trenton Potteries Company and in 1898 established the Monument Pottery. A short while before his death he undertook the building of the Sanitary Manufacturing Potteries at New Brighton, Pa.

Mr. Weelans served as President of the AMERICAN CERAMIC SOCIETY during 1911–1912, and was Vice-President during 1908–1909.

CHARLES WEELANS

Arthur Simeon Watts

A. S. Watts was born in Zanesville, Ohio, in 1876. After his graduation from the Zanesville High School, he took a short course in ceramics at the Ohio State University, and left this University in 1901. In 1909, he attended the Ceramic Fachschule at Bunzlau, Germany, and during 1910–1911, the Charlottenburg Technische Hochschule. From 1901 until 1909 he had professional connections with the F. M. Locke Insulator Manufacture, Victor, N. Y., the Bell Pottery Company, Findlay, Ohio, and the New Lexington Insulator Company, New Lexington, Ohio. During 1912–1913, he served as technologist with the United States Bureau of Mines.

In 1913 Professor Watts became Professor of Ceramic Engineering at the Ohio State University, which position he still retains. Since 1914, he has been at the head of this Department.

Professor Watts was editor of the *Transactions of the American Ceramic Society*, 1914–1917, inclusive, and was president of the SOCIETY during 1912–1913. He has been an associate contributor to Mineral Industry "Annual" since 1914, and from 1913–1917 acted as private counsel on porcelain for the Westinghouse Electric & Manufacturing Company. Since 1917, he has carried on a general consulting practice in addition to his teaching position. Professor Watts is a member of Sigma Xi and the American Society for Testing Materials. He has contributed numerous articles to the publications of the AMERICAN CERAMIC SOCIETY, as well as to the United States Bureau of Mines Bulletins.

ARTHUR S. WATTS

Cullen W. Parmelee

Cullen W. Parmelee was born in Brooklyn, New York, in 1874. He was graduated from Rutgers College in 1896 with the degree of B.Sc. and was elected to Phi Beta Kappa in his senior year for scholarship. Five years were spent as chemist with the New York and Boston Dyewood Company of Brooklyn, and in 1901 he returned to Rutgers College as instructor in chemistry. In 1903 Professor Parmelee organized the Department of Clay Working and Ceramics, and was Director of this Department until 1916. He served as Associate Professor of Applied Chemistry from 1905–1908 and as Professor of Ceramics from 1908–1916. In 1916

Professor Parmelee was appointed Professor of Ceramic Engineering at the University of Illinois. He served as acting head of this department during 1918–1919, and was again designated as acting head of the Department for 1922–1923.

C. W. PARMELEE

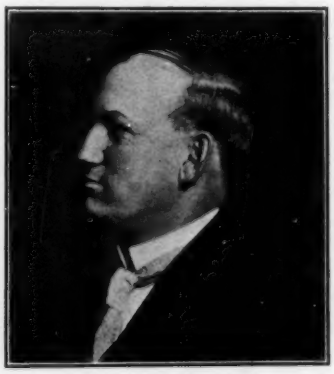
Professor Parmelee is the author of numerous papers which have appeared in the publications of the AMERICAN CERAMIC SOCIETY and other technical journals.

He has served as Trustee and Vice-President of the AMERICAN CERAMIC SOCIETY, and was President during 1914–1915. Professor Parmelee was Chairman of the Committee appointed to consider the publication by the SOCIETY of a journal, which resulted in the SOCIETY undertaking that enterprise. He is also a member of the Committee on Data of the SOCIETY.

Professor Parmelee organized the New Jersey Manufacturers' Association in 1914, and since 1917 has been Secretary of the Illinois Clay Manufacturers' Association. During 1918, he was appointed District Chieff or the Illinois Industrial Furnace Section of the United States Fuel Administration. He is a member of the Joint American Foundrymen's Association, and Division of Engineering, National Research Council Committee on Molding Sand Research. Since 1917, he has been consulting ceramist for the Illinois Geological Survey. Other organizations to which Prof. Parmelee is allied are the American Society for Testing Materials, American Chemical Society, the English Ceramic Society and Sigma Xi.

Richard R. Hice

Mr. Hice was president of the SOCIETY during 1915–16.



RICHARD R. HICE

Lawrence Eugene Barringer

Lawrence E. Barringer was born in Washington, D. C., in 1876 and received his degree in Ceramics (M.E.) in 1902. Previous to his college training Mr. Barringer was in the employ of E. M. Freese & Company of Gallion, Ohio, manufacturers of brick and tile machinery. His college course was interrupted also by temporary eye trouble. During the summer of 1897 he was with the Washington Brick Company in Washington, D. C., and the following summer was spent with the American Terra Cotta and Ceramic Company at Terra Cotta, Illinois. Following his graduation Mr. Barringer entered the services of the General Electric Company at Schenectady, New York, as a specialist in the production of porcelain. In 1908 he was made Engineer of Insulations for the General Electric Company. Mr. Barringer has invented a number of useful insulating products and has been granted fourteen patents which have been assigned to the General Electric Company.

Mr. Barringer served as President of the AMERICAN CERAMIC SOCIETY during 1916–1917. He also served as Chairman of the Committee on Publications from 1918 until 1921 and in this position undertook the launching of the *Journal*. Mr. Barringer has contributed to the technical writings of the *Journal*.

LAWRENCE E. BARRINGER

George Herbert Brown

Professor George H. Brown was born at Miamisburg, Ohio, in 1884, and in 1908 he received his degree of Ceramic Engineer at Ohio State University. From 1910 until 1914, he was Assistant Ceramic Chemist with the Bureau of Standards, and until 1916, was Associate in the same department. In 1916, he became Director of the Department of Ceramics at Rutgers College, New Brunswick, New Jersey, where he is still located. He is also Ceramic Engineer for the Hydraulic Press Brick Company.

PROF. GEORGE H. BROWN

Professor Brown was President of the AMERICAN CERAMIC SOCIETY, 1917–1918, editor of this *Journal* from its first issue, 1918 until 1920, and a Trustee of the SOCIETY from 1914 until 1917. He is also a member of the American Chemical Society and the American Society for Testing Materials.

Homer F. Staley

Homer F. Staley was born at New Philadelphia, Ohio, in 1879. He received his A.B. degree from the Ohio State University in 1904, and in 1909, he studied at Columbia University. From 1905 until 1909, Mr. Staley was superintendent in an enameled iron plant, and from 1909 until 1913, he was Professor in the Department of Ceramic Engineering at the Ohio State University. During 1912–1913, he was also technical director of the Standard Sanitary Manufacturing Company. In 1913, Mr. Staley went to Iowa State University as Professor of Ceramic Engineering, where he remained until 1919, when he became metallurgical ceramist with the Bureau of Standards. In 1921, he left the Bureau of Standards, and since that time, has been located in New York City with the Metal and Thermit Corporation.

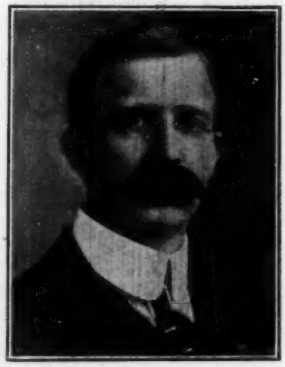
During 1919–1920, Mr. Staley served as President of the AMERICAN CERAMIC SOCIETY, and was Editor of the *Journal of the American Ceramic Society* in 1920, and until the latter part of 1922 served on the Committee on Publications. Mr. Staley was also editor of the *Transactions of the American Ceramic Society* for 1914 and 1915. He has contributed many articles on ceramic technology to various journals. He is also a member of the Committee on molding sand of the National Research Council.

HOMER F. STALEY

Ray T. Stull

Mr. Stull was born at Elkland, Pa., in 1875, and was graduated from Ohio State University in 1902. From 1902–1904 he was a chemist with the American Terra Cotta & Ceramic Co.; from 1905–1907, Superintendent of Mt. Savage Enameled Brick Works; from 1907–1909, Superintendent of Steiger Terra Cotta & Pottery Co., San Francisco, California; and Instructor in Ceramics, University of Illinois; Associate in Ceramics, University of Illinois, 1909–1910; Assistant Professor, 1910–1915; Ceramic Engineer, Dunn Wire Cut Lug Co., 1915–1917, and from 1917–1922 was Superintendent of the Ceramic Experiment Station, Bureau of Mines, Ohio State University, and Supervising Ceramist for the Bureau of Mines.

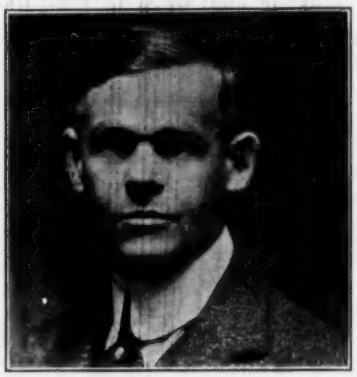
Mr. Stull was Vice-President of the AMERICAN CERAMIC SOCIETY in 1915–1916, and was President of the SOCIETY 1918–1919. He is also affiliated with Sigma Xi, and is an Honorary Member of the Illinois Clay Workers' Association.



RAY T. STULL

LeRoy Himes Minton

LeRoy H. Minton was born in Covington, Ohio, in 1882, descendant of the Minton family of potters in England. During his college course in vacations he worked at his trade as a brick layer. He was graduated from the Ohio State University in 1904 with the degree of M.E. in ceramics. Following his graduation he was employed as Ceramic Chemist in a refractory works and later became Chemist at the Mosaic Tile Company at Zanesville, Ohio. In the fall of 1906 he became Ceramic Chemist for the Perth Amboy Terra Cotta Company at Perth Amboy, N. J., and in 1913 he became Superintendent of the Wilkes-Barre Terra Cotta Company. In 1914, Mr. Minton went to Metuchen, N. J., where he became Superintendent of Plant No. 2, of the General Ceramics Company, and was made General Superintendent of this same Company in 1921.



L. R. H. MINTON

Mr. Minton is an active member of the AMERICAN CERAMIC SOCIETY. He served as President of the SOCIETY during 1920–1921 and has been a member of the Committee on Publications for the *Journal* for the past two years. Mr. Minton has contributed to the *Journal* of the SOCIETY as well as to other technical papers. He is also President of the New Jersey Clay Workers' Association and Eastern Section of the AMERICAN CERAMIC SOCIETY.

Forrest Kizer Pence

Forrest K. Pence of Zanesville, Ohio, was born in Sidney, Ohio, in 1883. His B.S. degree was received in 1903 from Ohio Northern University, his A.B. from the Ohio State University in 1907, and the degree of Ceramic Engineer from the latter University in 1909. From 1909 to 1912, Mr. Pence was Ceramic Engineer with the American Encaustic Tiling Company. For one year, Mr. Pence was Professor of Ceramic Engineering at Ohio State University, after which he returned to Zanesville to become Ceramic Engineer and Superintendent of Manufacture with the American Encaustic Tiling Company. He accepted the position of Research Ceramist with Knowles, Taylor and Knowles in the Spring of 1922.

Mr. Pence served as Vice-President of the AMERICAN CERAMIC SOCIETY during 1916–1917, and as President in 1921–1922. He is also a member of the American Chemical Society.

FORREST K. PENCE

Frank H. Riddle

Frank H. Riddle was born in Colorado Springs, Colorado in 1883. He has been connected with the ceramic industry since 1902, starting in the Van Briggle Art Pottery at Colorado Springs. From 1904 until 1907 Mr. Riddle took a special course in ceramic engineering at Ohio State University and was also part time instructor in the ceramic laboratory. After leaving school he became manager of the Van Briggle Pottery for three years. From 1910 to 1916 he engaged in work in heavy clay products plants in Ohio, British Columbia, and California. This work included construction and plant operation in sewer pipe and face and fire brick. He was then employed in the Clay Products Division of the United States Bureau of Standards at Pittsburgh from 1916 to 1919, as assistant to A. V. Bleininger in research work in special porcelains, including spark plug, also refractories for optical glass manufacture. Since 1919, he has been with the Champion Porcelain Company of Detroit, a branch of the Champion Spark Plug Company, and associated with Dr. J. A. Jeffery in research and plant control work for spark plugs and high tension insulators.

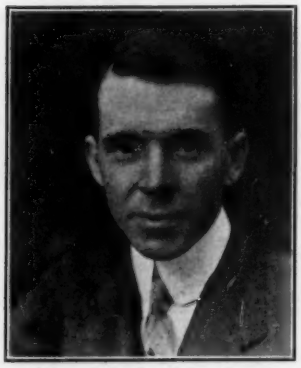
FRANK H. RIDDLE

Mr. Riddle is President of the AMERICAN CERAMIC SOCIETY at the present time. He has worked on Committees on Rules, Standards and Membership. He was Secretary of the Pittsburgh District Section and for three years served as a member of the Board of Trustees. Mr. Riddle has published several articles in the *Journal of the American Ceramic Society.*

Arthur F. Greaves-Walker

A. F. Greaves-Walker received his technical education in ceramics at the Ohio State University, completing his course in 1904. He has held the following positions:

Chemist and Mining Engineer, Olive Hill Fire Brick Company, Olive Hill, Kentucky, 1905–1906; Superintendent, Utah Fire Clay Company, Salt Lake City, Utah, 1907–1910; Superintendent, Southern Clay Manufacturing Company, Coaldale, Alabama, 1911–1912; Assistant General Manager of the Sun Brick Company, Toronto, Ontario, 1913–1916. From 1917 to the present time, he has been Production Manager of the American Refractories Company of Pittsburgh.



A. F. GREAVES-WALKER

During the World War, Mr. Greaves-Walker served as a volunteer and was appointed Chief of the Industrial Furnace Section of the United States Fuel Administration at Washington. This Section had jurisdiction over the entire ceramic, as well as all other non-metallic industries of this country during the War. As an author, Mr. Greaves-Walker has contributed liberally to the scientific and technological world, having seven contributions published in the *Transactions of the American Ceramic Society.*

Mr. Greaves-Walker is an active member of the AMERICAN CERAMIC SOCIETY, was Vice-President in 1918, Chairman of the Refractories Division in 1921, and Chairman of the Pittsburgh Section of the SOCIETY, 1922–1923. He also was appointed to fill out the unexpired term of Homer F. Staley on the Committee on Publications. Other organizations of which Mr. Greaves-Walker is a member are the American Electro-Chemical Society, Committee C-8 of the American Society of Testing Materials, English Ceramic Society, Royal Society of Arts, Fellow Utah Academy of Sciences, and the Canadian National Clay Products Association, of which latter association he was President in 1915.

Ralph Kent Hursh

Ralph K. Hursh was born in Woodstock, Illinois, in 1885. During 1903 and 1904 he attended school at Western Illinois State Teachers' College, following which he attended the University of Illinois. He was graduated from the University of Illinois in 1908 with the degree of B.S. During 1909, he was stock and shipping clerk for the Ohio Mining and Manufacturing Company, and from 1909 to 1911, was junior ceramic chemist at the Bureau of Standards. Since 1911, Professor Hursh has been teaching in the Department of Ceramic Engineering at the University of Illinois.

RALPH K. HURSH

Professor Hursh is an active member of the AMERICAN CERAMIC SOCIETY and, since 1917, has been Treasurer of the SOCIETY. He is also a member of the American Chemical Society. In his work in Ceramic Engineering, Professor Hursh is known chiefly for his research in drying and burning of clay wares and molding clay products.

Bert Eugene Salisbury

B. E. Salisbury was born in 1870 at Geddes, New York. He attended Cazenovia Seminary and 1890 entered the chemical laboratory of the Solvay Process Company.

In 1891 he associated himself with Pass & Seymour of Solvay, New York which firm was later incorporated. From the death of Mr. Pass in 1913 Mr. Salisbury was elected President of the Corporation which position he now holds. He also succeeded Mr. Pass as President of the Onondaga Pottery Company, Syracuse, New York.

Mr. Salisbury is an active member of the AMERICAN CERAMIC SOCIETY and is a Trustee of the SOCIETY. He is also a Past President and now a Vice-President of the United States Potters' Association. During the World War, Mr. Salisbury was Chairman of the Clay Division of the War Industry Board of the Syracuse District.

B. E. SALISBURY

B. T. Sweely

B. T. Sweely was graduated from Iowa State College Ceramics in 1917. After leaving school he was with the What Cheer Clay Products Company in Iowa for six months, after which he went to Chicago with the Western Electric Company of Chicago, Ill., Hawthorne Works. In 1920 he became Ceramist and Enameling Superintendent with the Coonley Mfg. Company where he remained until October, 1922, when he accepted a position with the Cribben & Sexton Company of Chicago.

B. T. SWEELY

Mr. Sweely is an active member of the AMERICAN CERAMIC SOCIETY and is Chairman of the Enamel Division of the SOCIETY, 1922–1923.

Raymond Miller Howe

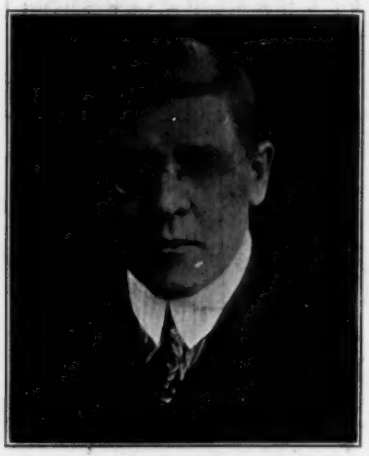
Raymond M. Howe was born in Elmira, New York, in 1894. His B.S. degree was received in 1915 from the New York State School of Clay Working and Ceramics at Alfred, New York. During 1915–1916, he was Fellow at the University of Pittsburgh, and received his A.M. degree in 1916. For one year, he was instructor in chemistry at the latter University, and since 1917, has been Fellow at Mellon Institute, in Pittsburgh.

Mr. Howe has contributed many articles to the *Journal of the American Ceramic Society*, and was Secretary of the Refractories Division of the SOCIETY in 1919. For the past two years, he has been a member of the Board of Trustees of the SOCIETY. He is also a member of the American Chemical Society and the American Society for Testing Materials, and during 1918, served on the Advisory Committee of the War Industries Board.

RAYMOND M. HOWE

Adolph F. Hottinger

Adolph F. Hottinger was born in Chicago, 1872, and has lived in that city all of his life. He attended the public schools until the age of eighteen when he entered the terra cotta business as an apprentice. He thus gained a practical experience in all departments. With the exception of about six months which were spent in a machine shop at machine design, he has been connected with the terra cotta business all of his life. After four years spent in the laboratory of a terra cotta company, he took a course in Chemistry in a private laboratory and was subsequently made ceramist in charge of the Northwestern Terra Cotta Company. This position he retained until 1916 when he was made factory manager of the same firm. He still occupies this position and is also treasurer of the same firm.



A. F. HOTTINGER

Mr. Hottinger is an active member of the AMERICAN CERAMIC SOCIETY and during the past year has served as Chariman of the Terra Cotta Division of the SOCIETY. Mr. Hottinger was Vice-President of the SOCIETY during 1913–1914 and trustee 1902–1905 and 1916–1919.

Edwin Ward Tillotson

E. Ward Tillotson was born at Farmington, Connecticut, in 1884. He was graduated from Yale University in 1909 following which he was Resident Fellow, Department of Research, at the University of Kansas. In 1913, Dr. Tillotson was made Assistant Director of Mellon Institute of Industrial Research, Pittsburgh, which position he still holds.

Dr. Tillotson is the author of many papers on the chemistry of glass which have appeared in various scientific journals and technologic magazines. He is Vice-President of the AMERICAN CERAMIC SOCIETY (1922–1923), served as Secretary of the Glass Division from 1919 to 1922 and since 1919 has been a member of the Committee on Publications. He is the SOCIETY Representative on Committee D-10, American Society for Testing Materials. Dr. Tillotson is also Councilor of the American Chemical Society.

E. W. TILLOTSON

Herford Hope

Herford Hope was born in London in 1883, came to the United States in 1898, and was apprenticed to the Mayer Pottery of Beaver Falls, Pennsylvania. He became foreman of the Mayer Pottery in 1904, and in 1906 took a position as superintendent of the Huntington China Company, Huntington, West Virginia. In 1907, Mr. Hope became instructor in Ceramics at the University of Illinois. In 1908, he returned to the Mayer Pottery as Assistant Manager of that Company.

Mr. Hope joined the United States Naval Reserve Force in 1917, and was made a commissioned ensign in 1918. In 1919, he returned to the Mayer Pottery, and in 1921, went to England as manager of the Colne Brick and Terra Cotta Company, Essex County. At the present time, he is operating an art pottery near Newton Abbott, Devon.

Mr. Hope is an active member of the AMERICAN CERAMIC SOCIETY, and from 1913 to 1917 was Treasurer of the SOCIETY.

HERFORD HOPE

Harrison Everett Ashley[1]

Harrison E. Ashley was born at New Bedford, Mass., in 1876 and obtained his collegiate training at the Massachusetts Institute of Technology from which he was graduated in 1900 with the degree of S.B. in Chemistry. Mr. Ashley specialized in metallurgy and after leaving school he took up the technology of foundry metal and steel, holding several positions in steel plants and foundries. He later entered the employ of the Homer-Laughlin China Company at East Liverpool, Ohio, and in 1908 entered Ohio State University, taking a special course of six months under Professor Orton. He was later transferred by the Homer-Laughlin China Company to their plant at Newell, West Virginia, upon the completion of that plant. In 1908, Mr. Ashley was appointed Assistant Ceramic Chemist with the Technologic Branch of the United States Geological Survey and in 1910 was transferred to the Bureau of Standards which position he held until his death.

HARRISON E. ASHLEY

Mr. Ashley was an active member of the AMERICAN CERAMIC SOCIETY and from 1909 until his death he served as Trustee of the SOCIETY. Mr. Ashley was a liberal contributor to technical literature.

Robert Dallas Landrum

Robert D. Landrum of Cleveland, Ohio, was born at Terre Haute, Indiana, in 1882. He received his degree of B.S. in 1904, and of M.S. in 1909 from the Rose Polytechnic Institute at Terre Haute, and in 1914, he took the degree of Chemical Engineer from the same institution. From 1904–1907, Mr. Landrum was chemist and enameler with the Columbian Enameling & Stamping Company of Terre Haute, and from 1907–1910 was Professor of Chemistry at the University of Kansas. He also held positions of

ROBERT D. LANDRUM

[1] Died February, 1911.

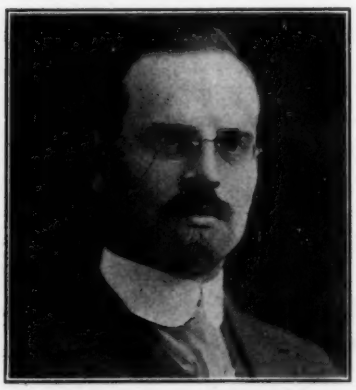
engineer with the Like Manufacturing Company of Canandaigua, New York, the Michigan Enameling Company of Kalamazoo, Michigan, and the General Stamping Company of Canton, Ohio. From 1914–1922, he was chemical engineer and manager of the Service Department of the Harshaw, Fuller and Goodwin Company of Cleveland, Ohio, and in 1922 was made vice-president of the Vitreous Enameling Company and Vitreous Steel Products Company of Cleveland, Ohio.

Mr. Landrum is the author of sixteen articles and technical papers in publications of this SOCIETY connected with the materials, methods and chemical analysis of enamel and enamel raw materials, and various processes in enameling

Mr. Landrum is an active member of the AMERICAN CERAMIC SOCIETY, and from 1918 to 1920, served as a trustee of the SOCIETY, and for the past two years, has been Chairman of the Committee on Papers and Program for the Annual Meeting of the SOCIETY. He was Chairman of the Enamel Division of the SOCIETY in 1920–1921 and Chairman of the Northern Ohio Section in 1921–1922. Other societies to which Mr. Landrum has allied himself are the American Chemical Society (Cleveland Section), America Institute of Chemical Engineers, the Cleveland Engineering Society, the Society of Chemical Industry (London), fellow of the A. A. A. S., and Société de Chimie Industrielle, Paris.

Edward Wight Washburn

Edward W. Washburn was born in Beatrice, Nebraska, in 1881. From 1899 to 1891, he was chemist at the University of Nebraska. In 1905, Dr. Washburn received his B.S. degree from the Massachusetts Institute of Technology, and his Ph.D. degree in 1908 from the same institution. He was Research Associate Chemist for two years at the Massachusetts Institute of Technology. From 1908 until 1910, he was Associate at the University of Illinois, Assistant Professor from 1910 to 1913, and Professor of Physical Chemistry from 1912 to 1916. In 1916, Dr. Washburn was appointed Professor of Ceramic Chemistry and head of the Department of Ceramic Engineering, where he was located until 1922, when he removed to Washington, D. C., as editor of the Annual Critical Tables of Physical, Chemical and Engineering Constants.



E. W. WASHBURN

Dr. Washburn is an active member of the AMERICAN CERAMIC SOCIETY, and served as Editor of this *Journal* during 1921, and part of 1922.

Dr. Washburn is a member of the National Research Council, and during 1918–1919, was Acting Chairman of the Chemical Division of the Council. In 1919, he was delegate to the International Chemical Union and International Research Council in London and Brussels, and in 1921, was American Commissioner on the International Commission of Annual Tables of Physical and Chemical Constants. Other organizations of which he is a member are the American Chemical Society, Physical Society, Society of Glass Technology, Illinois Academy, and Royal Society of Arts.

Fred B. Ortman

Fred B. Ortman was born at New Salem, Ohio, in 1888. He was graduated from the Ohio State University in 1911 with a degree of Ceramic Engineer. During 1909–1910

he worked with the Alton Brick Company, Alton, Illinois as laborer, kiln burner and foreman. From 1911 until 1917 Mr. Ortman worked as Assistant Ceramist, Chief Ceramist, Assistant General Manager and Sales Manager for the New York Architectural Terra Cotta Company, Long Island City, New York. He was Chief Ceramist with the Northwestern Terra Cotta Company of Chicago from 1917 until 1920 and since that time has been Vice-President and General Manager of the Tropico Potteries, Inc., Glendale, California.

FRED B. ORTMAN

Mr. Ortman is an active member of the AMERICAN CERAMIC SOCIETY and served as Vice-President of the SOCIETY during 1921 and as trustee during 1922 filling out the unexpired term of Mr. Riddle. During 1918–1919 he was Chairman of the Terra Cotta Division and in 1919 was Secretary of the Chicago Division of the SOCIETY. Mr. Ortman is a member of the Board of Trustees at the present time.

Earl T. Montgomery

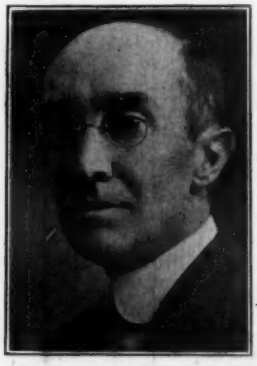
Earl T. Montgomery received his degree of Engineer of Mines in Ceramics in 1907, and spent the two years following his graduation as Superintendent of the Wirt Manufacturing Company at Burrage, Massachusetts. He also spent a year in the engineering department of the Kinnear Manufacturing Company, at Columbus, Ohio. During 1910–1911, Mr. Montgomery was instructor in Ceramic Engineering at the University of Illinois, and for two years, was Assistant Ceramic Chemist with the United States Bureau of Standards, Pittsburgh Laboratory. From 1913–1916, he was Professor of Ceramic Engineering at the New York State School of Ceramics, Alfred, New York, leaving Alfred in 1916 for Detroit, where he was Director of Research with the Jeffery-Dewitt Company (now the Champion Porcelain Company). Since 1919, Mr. Montgomery has been President and Manager of the Montgomery Porcelain Products Company of Franklin, Ohio.

EARL T. MONTGOMERY

Mr. Montgomery is an active member of the AMERICAN CERAMIC SOCIETY, and served as trustee from 1917 to 1919. In 1920 he was elected Vice-President of the SOCIETY. He is the author of several technologic papers published by the Bureau of Standards and in the publications of the AMERICAN CERAMIC SOCIETY.

Harold Phelps Humphrey

H. P. Humphrey was born in 1881 at Osceola, Pa., and received his E.M. degree in ceramics from Ohio State University in 1904. The year following his graduation he was connected with the Cook Pottery Company at Trenton, N. J., in 1906 and 1907 he was ceramist with the Northeastern Terra Cotta Company at Bradford, Pa., and in 1908 was Assistant Superintendent of the plant of



H. P. HUMPHREY

the Cook Pottery Company at Ford City, Pa. For six years, from 1909 to 1914 Mr. Humphrey was Superintendent of the Prospect Hill Works of the Cook Pottery and until 1917 was Vice-President and general manager of the same firm. In 1918 he became Vice-President and general manager of the Washington Porcelain Company at Washington, New Jersey, which position he still retains.

Mr. Humphrey is an active member of the AMERICAN CERAMIC SOCIETY and served as trustee for the SOCIETY from 1912 to 1915.

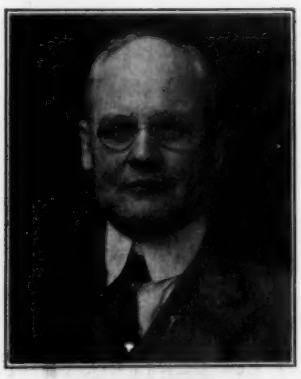
Dwight Thompson Farnham

Dwight T. Farnham was born at Candor, New York, in 1881. He was graduated from Yale with the degree of A.B. in 1904. His first positions in the ceramic industry were with the Clermont and Shamut Manufacturing Companies of Pennsylvania, 1904–1906, and from 1906 to 1914, Manager of the Denny Renton Clay and Coal Company of Seattle, Washington. For two years following, Mr. Farnham was supervising engineer of the Emerson Company. He established a consulting practice in St. Louis, Missouri, and during the War, from 1916 to 1920, did special work for the Emergency Fleet Corporation and Ordnance Department. He subsequently did consulting industrial engineering work for the Evens and Howard plants, and for the LaClede-Christy Plants in St. Louis, Missouri. During 1920, Mr. Farnham studied industrial conditions in France, Italy, Germany and England, and in 1921, became Vice-President and Director of the C. E. Knoeppel & Co., Inc., in New York City. In 1922, Mr. Farnham, with Irving A. Berndt, opened offices for consulting practice in New York City.

DWIGHT T. FARNHAM

Mr. Farnham is an active member of the AMERICAN CERAMIC SOCIETY, and during 1914–1915 was Vice-President of the SOCIETY.

He is Vice-President and Director of the Society of Industrial Engineers, a member of the American Society of Mechanical Engineers, Yale Engineering Society, and the National Personnel Association. He has contributed to the *Journal of the American Ceramic Society*, and also to other journals and magazines, his subjects in general dealing with industrial efficiency and control.



WM. J. CANNAN

W. J. Cannan

W. J. Cannan was born in 1875 and at the age of fifteen was working for the E. M. Freese Manufacturing Company of Gallion, Ohio. Of the thirty-three intervening years he spent six years in the manufacture of clay machinery, and two in the manufacture of paving brick and heavy clay ware. He also served six months in the Navy during the Spanish American War. Following the War he took a short course of two and one-half years

at the Ohio State University. Fifteen out of eighteen years since completing this short course he has spent in the Onondaga Pottery Company of Syracuse, New York, where he is now General Superintendent.

Mr. Cannan is an active member of the AMERICAN CERAMIC SOCIETY and served as trustee of the SOCIETY from 1910 until 1913.

Frederick H. Rhead

Frederick H. Rhead was born at Hanley, Staffordshire, in 1880. He comes of a family of artists and potters for several generations. He was apprenticed at Brownfields of Cobridge in 1893, having attended local art schools before that time. For three years previous to coming to this country he was instructor in Government Art School at Longton. During this time he was also a special artist at Foresters Art Pottery in Longton. Two years were spent with his father during the building and organizing of the art pottery for Wileman & Company, Longton, and two years more as Art Director of Wardle Pottery of Hanley. After coming to the United States Mr. Rhead was Art Director of the Roseville Potteries, Zanesville, Ohio for six years and for five years was President and General Manager of the Rhead Pottery of Santa Barbara, California. His work received gold medals at the St. Louis Exposition as well as the World's Fair Exposition at San Diego, California. For the past four years Mr. Rhead has been Director of Research and Active Head of the Art Department of the American Encaustic Tiling Company, Zanesville, Ohio, Maurer, N. J., Los Angeles, California and New York City. Mr. Rhead has contributed to numerous art journals, articles in Research Reports on ceramic processes and designing and has lectured widely on his subject. He has also exhibited his work frequently.

FREDERICK H. RHEAD

Mr. Rhead is an active member of the AMERICAN CERAMIC SOCIETY and is Chairman of the Art Division, having organized that Division of the SOCIETY. He is also a member of the English Ceramic Society, English Chemists' Club and the Architectural League of New York City.

MABEL C. FARREN

Mabel C. Farren

Miss Mabel C. Farren was a student for four years in the Allegheny School of Art and the Art Students' League under the direction of Martin Borgord, specializing in drawing and painting. She also spent two years modeling with August Zeller at the Carnegie Institute, and two years were also spent in studying Interior Decoration at the School of Fine Arts, Carnegie Institute. Miss Farren won the medal of the First Class, Duquesne Ceramic Club for Ceramic Design and Decoration in 1902 and in 1903 she won medals of the same organization for Second and Third Class. In 1911 she was honored with the medal of the third class by the Society of Beaux Arts.

From 1900 until 1908 Miss Farren conducted a private studio and for two years following was instructor in Pottery and Design in the Art Students' League of Pittsburgh. For five years, from 1910 until 1915, she served as instructor of design and ceramics at the Carnegie Institute of Technology. During the summer of 1911 she studied with Frederick H. Rhead at the St. Louis School of Ceramics.

HERBERT L. KIRK, New Castle, Pa.

Miss Farren was the first woman member of the AMERICAN CERAMIC SOCIETY and for two years served as Secretary of the Art Division of the SOCIETY. She is also a member of the Art Alliance of America and the Art Society of Pittsburgh.

Herbert L. Kirk

Herbert L. Kirk was born in 1895 at New Castle, Pa. The year 1914–1915 he spent working in a pottery laboratory in New Castle and from 1915 until 1917 he studied chemical engineering and business administration at Lehigh University. From 1917 until 1919 he was a member of the United States Naval Reserve Force and saw service in France. After his discharge from service he became associated with the Universal Sanitary Manufacturing Company, of New Castle, Pa., which position he retains as Sales Manager and Research Engineer.

Mr. Kirk is an active member of the AMERICAN CERAMIC SOCIETY and is now serving as Secretary of the Art Division of the SOCIETY.

Ralph R. Danielson

R. R. Danielson was born in Chicago, Ill., in 1892, and was graduated from Crane Technical School in 1910. In 1914, he was graduated from the University of Illinois with degree of B.S. in Ceramic Engineering, and took a post-graduate course, securing the degree of M.S. in Ceramic Engineering in 1916.

From 1914–1916 he was instructor in Ceramic Engineering, University of Illinois; from 1916–1919, Ceramic Engineer, Royal Enameling Co. and Benjamin Electric Co., Desplaines, Illinois; from 1919–1920, Enamel Technologist, U. S. Bureau of Standards, Washington, D. C., and since 1920 has been Chief of the Enameled Metals Section, U. S. Bureau of Standards.

Mr. Danielson is an active member of the AMERICAN CERAMIC SOCIETY, and is now Secretary of the Enamel Division. He has contributed numerous papers to the *Journal of the American Ceramic Society*.

R. R. DANIELSON

Charles Edwin Jackson

C. E. Jackson was born in 1874 at Hanley, Staffordshire, England, and emigrated to this country in 1882. His family for many generations has been connected with pottery manufacture. He left school when he was fourteen years of age and was employed by the Wheeling Pottery Company as an apprenticed mould maker, later taking up other

work in the factory. At the age of twenty-five Mr. Jackson became a student of the ceramic department at Ohio State University, completing the short course in ceramics in 1902. For three years he was ceramic engineer for the Wheeling Pottery Company and from 1905 until 1910 he was ceramic engineer for the Onondaga Pottery Company, Syracuse, N. Y. On January 1, 1911, Mr. Jackson was elected president and general manager of the Warwick China Company of Wheeling, W. Va., where he is located at the present time.

Mr. Jackson is a member of the AMERICAN CERAMIC SOCIETY, of which he was Vice-President in 1917–18.

EMERSON P. POSTE

Emerson P. Poste

Emerson P. Poste was born in Naples, New York, in 1888. He received his degree of B.S. from the Department of Chemical Engineering, Carnegie Institute of Technology, Pittsburgh, Pa., in 1910. From 1910 to 1912, he was assistant instructor and research assistant to the head of the Department of Chemical Engineering, Carnegie Institute. From 1912 to 1916, Mr. Poste was chemist with the Enameled Pipe & Engineering Company of Elyria, Ohio, and from 1916 to the present date, he has been director of laboratories of the Elyria Enameled Products Company, Elyria, Ohio.

Mr. Poste is an active member of the AMERICAN CERAMIC SOCIETY. He was Chairman of the Northern Ohio Section of the SOCIETY from 1918–1920, as well as Chairman of the Enamel Division during 1920–1921. During 1922–1923, he has served on the Committee of Standards as a representative of the Enamel Division, and is a member of the Standing Committee on Membership.

Mr. Poste is also a member of the following technical organizations: American Chemical Society, American Institute of Chemical Engineers, American Association for the Advancement of Science, American Welding Society, Cleveland Engineering Society, English Society of Glass Technology.

Arthur E. Williams

Arthur E. Williams was born in Cleveland, Ohio, in 1886. He received his B.S. degree in ceramics at the University of Illinois in 1910 and his Master's Degree in ceramic engineering from the same University in 1916. During the year 1910–1911 he was superintendent of the Monmouth Brick and Tile Company at Monmouth, Illinois, and the following year was assistant to the foreman and kiln fireman for the Western Brick Company at Danville, Illinois. From November, 1913, until July, 1916, Mr. Williams was instructor in the Department of Ceramics at the University of Illinois, and since that time has been Ceramic Chemist for the Glass Section of the United States Bureau of Standards, at Washington, D. C.

A. E. WILLIAMS

Mr. Williams is an active member of the AMERICAN CERAMIC SOCIETY and has been a frequent contributor to the *Journal* of the SOCIETY as well as to other technical publications. He is secretary of the Glass Division.

J. C. Hostetter

J. C. Hostetter was born in Williamsport, Pa., in 1886. After graduating in the chemical course from Bucknell University, he pursued graduate work there and at the University of Chicago. From 1908 until 1910 he was instructor in chemistry at Bucknell University and was assistant chemist at the Bureau of Standards from 1910 to 1912. Mr. Hostetter then became physical chemist at the geophysical laboratory, Carnegie Institution of Washington. In 1919, he took up the manufacture of colored glassware at the Steuben Division of the Corning Glass Works and in 1920 was made manager of this Division. He is now Assistant to the Vice-President in Charge of Operations of the Corning Glass Works.

J. C. HOSTETTER

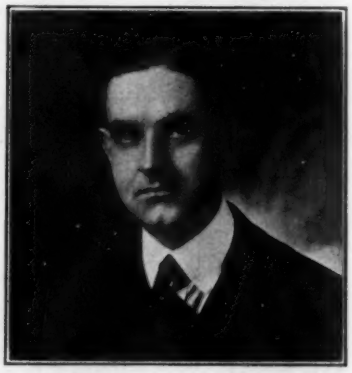
Mr. Hostetter is an active member of the AMERICAN CERAMIC SOCIETY, served as Vice-Chairman of the Glass Division for 1921–22 and Chairman for 1922–23. He is also a member of the American Chemical Society, Washington Academy of Sciences, Washington Philosophical Society, and Society of Glass Technology. Mr. Hostetter has contributed many articles to this *Journal* and other scientific publications.

M. B. Greenough

Mr. Greenough is Secretary of the Heavy Clay Products Division of the SOCIETY.

M. F. Beecher

M. F. Beecher was graduated from Iowa State College in 1910 with the B.S. degree and in 1915 received the degree of Ceramic Engineer from the same school. Following his graduation he was employed as yard foreman with the Boone Brick Tile & Paving Company, Boone, Iowa and later was assistant to the superintendent at plant No. 2 of the Western Stoneware Company of Monmouth, Illinois. In the latter part of 1911 Mr. Beecher returned to Ames, Iowa, to became assistant ceramic engineer at the Engineering Experiment Station. In 1915 he entered the employ of Norton Company, Worcester, Mass., to work on refractories in the research laboratories. He was put in charge of the ceramic section of this Company in 1916 and since 1919 has been research engineer, assuming general charge of the Laboratories at Worcester. Mr. Beecher has contributed articles on clay to the publications of the AMERICAN CERAMIC SOCIETY.



MAURICE B. GREENOUGH

Mr. Beecher is an active member of the AMERICAN CERAMIC SOCIETY, serving one term as Trustee from 1919–1922 and from 1917–1922 was Chairman of the Committee on Standards.

C. Forrest Tefft

C. Forrest Tefft was graduated from the New York State School of Ceramics and Clay Working at Alfred, N. Y., in 1914. Previous to his graduation he had five years' experience in the roofing tile business with the Ludowici-Celadon plant, first in their plant at Alfred, N. Y., and later in the plant at Coffeyville, Kansas. During his senior year at college the New York State Student Branch of the American

Ceramic Society was organized and Mr. Tefft was made its first President. Mr. Tefft is now Assistant Factory Manager for Fiske and Company, Inc., with headquarters at Watsontown, Pa., where the main office of the Company is located.

Mr. Tefft is an active member of the AMERICAN CERAMIC SOCIETY and for the past year has been Chairman of the Heavy Clay Products Division of the SOCIETY.

C. FORREST TEFFT

Frederick Addison Harvey

Frederick A. Harvey was born at Kellogg, Iowa, in 1882. He took his B.S. degree at Grinnell College in 1904 and during 1908–1909 worked under a Whiting Fellowship at the University of California and received his degree of Ph.D. in 1909. During 1909–10, Dr. Harvey was Instructor in physics at Grinnell and the following year held the same position at the University of Syracuse. In 1916, Dr. Harvey left this University where he was Associate Professor and became Physicist for the Semet-Solvay Company of Syracuse. Since 1921 Dr. Harvey has been connected with the United States Refractories Corporation at Mt. Union, Pa.

FRED A. HARVEY

Dr. Harvey is an active member of the AMERICAN CERAMIC SOCIETY, is serving as Secretary of the Refractories Division and has contributed articles to the *Journal*. He is a member of the A. A., an associate of the Physical Society and of the American Chemical Society.

J. Spotts McDowell

J. Spotts McDowell is a graduate of the Massachusetts Institute of Technology where he received his B.S. degree. He is an active member of the AMERICAN CERAMIC SOCIETY and is Chairman of the Refractories Division. Other technical and scientific societies of which he is a member are the American Chemical Society, American Society for Testing Materials, American Electrochemical Society, American Institute of Mining and Metallurgical Engineers, Engineer's Society of Western Pennsylvania, Society of Glass Technology (British) and the Ceramic Society (English).

J. SPOTTS MCDOWELL

Robert L. Clare

Mr. Clare was graduated from the Ohio State University in 1912, with the degree of Ceramic Engineer. He worked with Professor Orton at the University and at his laboratory during the last year of his college course.

After graduation, he was connected with Richardson-Lovejoy Engineering Co. as engineer

ROBERT L. CLARE

and draughtsman; with Macon, Dublin & Savannah Railroad as prospecting engineer to locate bauxite properties in southern Georgia; with Federal Terra Cotta Co. in 1913 as Ceramic Engineer, subsequently as Assistant Superintendent, and finally as Superintendent, which position he has held since 1916.

Mr. Clare is an active member of the AMERICAN CERAMIC SOCIETY, and is serving as Secretary of the Terra Cotta Division. He is also a member of the Technical Committee, National Terra Cotta Society.

Chester H. Treischel

Chester H. Treischel was born at Martinton, Illinois, in 1894. In 1916, he received his degree of B.S. in Ceramic Engineering at the University of Illinois. The year following his graduation, he spent with the Kankakee Tile and Brick Company, and in 1917 he became ceramic engineer with the General Electric Company at Schenectady, New York, and was transferred recently by the same Company to Pittsfield, Massachusetts.

CHESTER H. TREISCHEL

Mr. Treischel is an active member of the AMERICAN CERAMIC SOCIETY, and is Secretary of the White Wares Division. He has also contributed articles of ceramic interest to this *Journal*.

Le Roy W. Allison

Le Roy W. Allison was born in 1884 and received his education in Brooklyn, N. Y. He first took up electrical and mechanical engineering in New York and Los Angeles. In 1910 he took up technical and business journalism, later returning to New York to continue his work with the technical press. Since 1917 he has devoted his entire time and efforts to technical journalism and engineering advertising. Mr. Allison became identified with the ceramic industry of New Jersey about five years ago. He is now editor of *The Ceramist*, a publication for the New Jersey Clay Workers' Association and Eastern Section of the AMERICAN CERAMIC SOCIETY. He has been advertising manager for the *Journal of the American Ceramic Society* since 1920. Mr. Allison is also a member of the A. A. S., associate member of the American Institute of Electrical Engineers and a fellow member of the American Geographical Society.

L. R. W. ALLISON

Joseph B. Shaw

J. B. Shaw was graduated from Ohio State University in 1908, and became superintendent of the enameling department of the Grand Rapids Refrigerator Company of Grand Rapids, Michigan. During 1911–1912, he did

ceramic research work with the Andrew Ramsey Company of Mount Savage and Ellerslie, Maryland, and from 1912 to 1915, conducted ceramic research in the Pittsburgh Testing Laboratory. From 1915 until the present time, Professor Shaw has been Assistant Director and Professor of Ceramic Engineering at the New York State School of Clay Working and Ceramics, Alfred, New York.

Professor Shaw is an active member of the AMERICAN CERAMIC SOCIETY, and has served on the Committees on Rules, Standards, and Sections and Divisions. During 1918–1922 Professor Shaw was treasurer of the New York State Section of the AMERICAN CERAMIC SOCIETY and is Councillor for the New York State Student Branch of the SOCIETY. At the present time, Prof. Shaw is the representative of the Enamel Division on the Committee on Rules. He has made numerous contributions to the publications of the AMERICAN CERAMIC SOCIETY, as well as to other technical and scientific publications.

PROF. J. B. SHAW

Charles H. Kerr

C. H. Kerr was born at Cleveland, Ohio, in 1884. He completed his ceramic course at Ohio State University in 1906, having received his degree of E.Min. in Cer. From 1907–1908, he was chemist for the Carborundum Co., Niagara Falls, N. Y., leaving that firm to pursue the same work with the American Optical Co., Southbridge, Mass. He then became Director of the Research Laboratory of the Pittsburgh Plate Glass Co., Pittsburgh, Pa., 1911–1917. In 1917, he accepted the position of Research Manager of the American Optical Co., Southbridge, Mass., which he held until 1920. At present he is connected with the De-Zeng Standard Co., Camden, N. J., being its Vice-President and Secretary.

CHARLES H. KERR

Mr. Kerr is an active member of the AMERICAN CERAMIC SOCIETY, having called the organization meeting of the Glass Division and being appointed its first Chairman. He is also a member of the American Chemical Society, Society of Glass Technology and a charter member of the Optical Society of America. At present he is Assistant Editor of *Chemical Abstracts*.

Walter A. Hull

Walter A. Hull was graduated from Ohio State University in 1902 with the degree of Engineer of Mines in Ceramics. He spent twelve years in industrial work, mainly in executive positions connected with the manufacture of refractories and other heavy clay products. For nearly nine years past, he has been connected with the United States Bureau of Standards, working first on the study of fire-resistive properties of building materials, and more recently on ceramic problems.

He is a member of the AMERICAN CERAMIC SOCIETY, and for the past year has served as the Chairman of the Committee on Standards. He is also a member of the

WALTER A. HULL

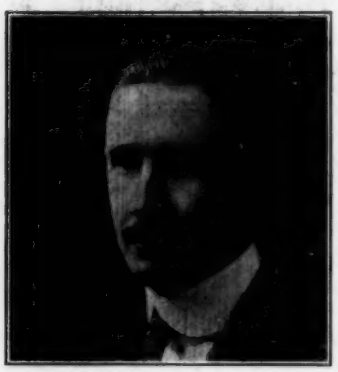
American Iron and Steel Institute, and American Society for Testing Materials. In connection with the latter organization, he is a member of the following committees: C-4 on Clay and Cement Sewer Pipe, C-8 on Refractories, C-11 on Gypsum, and D-9 on Electrical Insulating Materials. He is chairman of Committee C-10 on Hollow Building Tile of the A. S. T. M. Other committees on which Mr. Hull serves are the Executive Committee and Committee on Building Construction of the National Fire Protection Association.

William M. Clark

William M. Clark was born in Derby, Conn., in 1880. He was graduated from Sheffield Scientific School, Yale University, in 1901 and pursued his post-graduate work at the Mass. Institute of Technology. In 1902, Mr. Clark studied at the Polytechnikum, Zürich, Switzerland and in 1903 he attended the University of Berlin and Charlottenburg Technical School. From 1904 until 1906 he was located in London, Eng., following which he returned to New York and took a position with the General Chemical Co. where he remained until 1911. Since 1911 he has been affiliated with glass interests of National Lamp Works of the General Electric Co. at Cleveland, Niles, Fostoria and Newark, Ohio, his present position being Manager of the Glass Technology Department located at Nela Park, Cleveland, Ohio.

WM. M. CLARK

Mr. Clark is an active member of the AMERICAN CERAMIC SOCIETY and is at present Chairman of the Committee on Research. He also served as Chairman of the Glass Division in 1921.



O. O. BOWMAN, 2ND

O. O. Bowman, 2nd

O. O. Bowman, 2nd, entered Rutgers College in 1913 following his graduation from Lawrenceville School. He completed a two-year course in Ceramics under Professor Parmelee and in 1915 took a position with the Trenton Fire Clay & Porcelain Company which is a subsidiary company of the J. L. Mott Company. His work began in the laboratory and when he left this Company in October, 1922 he was Manager. In 1920, Mr. Bowman and his brother formed the Bowman Coal Company of Trenton, N. J., and due to the growth of this organization a branch office of this Company was opened in Philadelphia and Mr. Bowman relinquished his ceramic business to devote all of his time to the new work.

Mr. Bowman is an active member of the AMERICAN CERAMIC SOCIETY, serving on the Executive Committee of the White Wares Division as well as acting as Chairman

of the Membership Committee. He is also an active member of the New Jersey Clay Workers' Association and Eastern Section of the AMERICAN CERAMIC SOCIETY.

T. A. KLINEFELTER

T. A. Klinefelter

T. A. Klinefelter graduated from the Ohio State University and has been active in the ceramic industry through the following positions: Ceramic Engineer with the Westinghouse Electric and Manufacturing Company of East Pittsburgh, Pa., Plant Superintendent of the Atlantic Terra Cotta Company of Tottenville, New York, and Production Manager of the Pottery Department of the J. L. Mott Company of Trenton, New Jersey.

He is an active member of the AMERICAN CERAMIC SOCIETY, and chairman of Committee on Rules and is the representative from the Terra Cotta Division on the Committee on Data.

Thomas Poole Maynard

T. Poole Maynard was born at Baltimore, Md., 1883. In 1905 Dr. Maynard received his A.B. degree from Johns Hopkins University and his Ph.D. degree in 1909. From 1905 until 1908 he was assistant geologist at Hopkins and Assistant State Geologist of the Georgia Geological Survey from 1909 until 1912. Since that time he has been a Consulting Geologist at Atlanta, Georgia. Dr. Maynard was a member of the Maryland and Virginia Geological Surveys from 1905 until 1909 and in 1907 was with the United States Geological Survey.

Dr. Maynard is an active member of the AMERICAN CERAMIC SOCIETY and is Chairman of the Committee on Geological Surveys of the SOCIETY. He is also a member of the Geological Survey, the Paleontological Society, Mining Engineers, Electro-Chemical Society and others.

A. F. GORTON

Arthur F. Gorton

Arthur F. Gorton was born in Baltimore, Md., and received his A.B. degree in 1912 in Johns Hopkins University. In 1914 he took his A.M. degree, was made Fellow in Physics, 1914–1915, and in 1915 received his Ph.D. degree. During 1915–1916 he was instructor in Physics at the University of Minnesota and held the same position the following year at Johns Hopkins University. From 1917 until 1920 he was ceramist in charge of the laboratory and plant research for the Buckeye Clay Pot Company, Toledo, Ohio and since 1920 has been physicist for the research laboratory of the National Malleable Castings Company, Cleveland, Ohio.

Mr. Gorton is an active member of the AMERICAN CERAMIC SOCIETY and served as Chairman of the Northern Ohio Section of the SOCIETY during 1920. During 1922–1923 he served as Secretary-Treasurer of the Northern Ohio Section.

J. W. Hepplewhite

J. W. Hepplewhite was born at Audenried, Pa. He received his Bachelor's degree in ceramic engineering at Ohio State University in 1920. Since his graduation he has been employed by the Koppers Company's laboratories in Pittsburgh, working on research and standardization of refractories for the by-product coke oven. During 1918 and 1919, he was ceramic assistant at the Bureau of Mines, Ceramic Experiment Station, Columbus, Ohio. Since December 1922, Mr. Hepplewhite accepted a position as ceramic engineer with Johns Manville, Inc., Manville, N. J.

J. W. HEPPLEWHITE

Mr. Hepplewhite is an active member of the AMERICAN CERAMIC SOCIETY and until December, 1922, acted as Secretary of the Pittsburgh District of the AMERICAN CERAMIC SOCIETY.

Charles W. Saxe

Charles W. Saxe was graduated from the Rensselaer Polytechnic Institute, Troy, N. Y., in 1910. For two years he was located with the Lederle Laboratories of New York City on chemistry and bacteriological work and later became chemist in charge of a new water filtration plant at Newport, R. I. He also filled a similar position for two years at Waco, Texas. For a year and a half Mr. Saxe was in charge of the clay testing laboratory at the Norton Company, and by leave of absence served as filtration plant chemist at the Panama Canal under the department of Operation and Maintenance. Mr. Saxe is again with Norton Company as Supervisor of refractories production and since 1920 has been head of the refractories sales department.

CHARLES W. SAXE

Mr. Saxe is an active member of the AMERICAN CERAMIC SOCIETY and is Secretary of the New England Section of the SOCIETY.

F. G. JAEGER

Frank G. Jaeger

Frank G. Jaeger was born in St. Louis, Mo., in 1872. He was in the employ of the largest stove plant in St. Louis for thirty-two years until he, with several others, organized the Superior Enameled Products Company. Since the beginning of this firm Mr. Jaeger has been Vice-President and General Manager and all formulas used by this firm have been developed by Mr. Jaeger personally.

Mr. Jaeger is an active member of the AMERICAN CERAMIC SOCIETY and since 1921 has been Chairman of the St. Louis Section of the SOCIETY. He is active in the work of the Enamel Division.

Alexander Silverman

Mr. Silverman was born in 1881, and received the following education: University of Pittsburgh (Ph.B. 1902, M.S. 1907), Cornell University (A.B. 1905). From 1902–1904 he was a chemist with Macbeth-Evans Glass Co., conducting researches. Since 1905 he has been on the chemistry faculty of the University of Pittsburgh, and is now head of the Department of Chemistry.

He has lectured at various universities, and is the author of two books. He has also contributed numerous papers to various technical journals.

Mr. Silverman is Chairman of the Pittsburgh Section of the AMERICAN CERAMIC SOCIETY, and is also a member of the American Chemical Society, American Electrochemical Society, Technical Photographic and Microscopical Society and the Society of Glass Technology (London).

ALEXANDER SILVERMAN Chairman Pittsburgh Section.

OUR OFFICE FORCE

The personnel of the secretarial and editorial office for several years consisted of but one person, Miss Metta L. Seymour. Miss Seymour came to Prof. Orton in the fall of 1899, keeping the records of the SOCIETY as one of the routine tasks. During the later years of Prof. Orton's incumbency as Secretary and Editor, Miss Seymour devoted most of her time to the affairs of the SOCIETY, and was officially recognized as Assistant Secretary. From 1899 to 1917, she thus served the SOCIETY.

METTA SEYMOUR

NORAH W. BINNS

Our present force is here shown. Miss Norah W. Binns, the Assistant Secretary, is well known. She has served in this capacity for five years,

the first four being with her father, who was Secretary of the SOCIETY from 1917 to 1922. She was graduated from Alfred University in 1912.

Miss Emily C. Van Schoick was Assistant Editor under Dr. E. W. Washburn for a few months prior to the consolidation of the two offices

EMILY VAN SCHOICK

HELEN M. ROWLAND

last March. Miss Van Schoick is a graduate of Illinois Wesleyan University, and was at the University of Chicago Press in Chicago for two years before she became editorial assistant for this *Journal*.

Miss Helen Rowland is a recent addition to our force in the dual capacity of second assistant secretary and editor.

CORPORATION MEMBERS

The SOCIETY from the first has continued the policy of low personal membership fees, so that the young men in the industries may have the rights and benefits of membership without inordinate strain on their financial resources. To do this, it is necessary that the manufacturing firms contribute to the support of the SOCIETY, hence the provision for corporation memberships.

The researches reported, and the results of research and educational promotional activities of the SOCIETY have resulted in large savings to the industries. Testimonials of this are frequently heard. It will be readily conceded that if it had not been for the activities of this SOCIETY and similar organizations during the past quarter century, ceramic manufacturing would not have kept pace in competition and with the general cost advances. And certainly the ceramic manufacturers would not today be in so favorable a position for meeting the new, and the often recurring emergency demands on ceramic wares. Whereas, a quarter of a century ago, there were ceramists who had acquired the ability and knowledge to produce certain special wares, such as the finest pottery, efficient grinding wheels, excellent refractories and durable terra cotta, such special

ability was possessed by very few, and these few were employed as specialists who guarded their knowledge very zealously as trade secrets. The ceramic industries could not meet the production demands of today with such uniformly excellent quality of ware if still dependent upon these "experts."

Manufacturing on a large scale within permissible operating costs and producing uniform quality of ware from week to week would have been impossible without the modern equipment and methods, and especially without the modern systems for plant control. Corporations have been very largely financially benefited by the researches of the scientists, artists and engineers whose findings have been pyramided into definite factory methods, devices and mixtures.

This SOCIETY has served and will continue to serve as one of the essential agencies through which such information is cleared and in which it is pyramided. The technical press, the universities, the research bureaus and institutes are essential agencies in the technical advancement in the industries, but none of these are more essential than the technical organizations such as this SOCIETY.

Twenty-five dollars a year does not represent the benefits which accrue to each manufacturing concern from the activities of this SOCIETY, hence it is not from an altruistic motive that corporations give financial support to this SOCIETY as corporation members. Their support is given that their employees may keep abreast with the increasing fund of technical information at the minimum personal cost.

Here are the names of those who were on record December 1, 1922, as corporation members[1] of this SOCIETY:

Abrasive Co. (Louis L. Byers), Tacony & Fraley Sts., Bridesburg, Philadelphia, Pa.
A C Spark Plug Co. (Taine G. McDougal), Flint, Mich.
Acme Brick Co. (Douglas F. Stevens), 412 Adams Bldg., Danville, Ill.
Alexander Hamilton Institute (D. E. Beebe), Astor Place, New York City.
The Alhambra Tile Co. (J. F. Sheehy, Pres.), Newport, Ky.
American Dressler Tunnel Kilns, Inc. (Philip Dressler), Cleveland, Ohio.
American Emery Wheel Works (W. E. Richmond), Providence, R. I.
American Encaustic Tiling Co. (H. D. Lillibridge), Zanesville, Ohio.
American Rolling Mill Co. (A. J. Aupperle), Middletown, Ohio.
American Stove Co. (G. F. Foske, Treas.), 2001 S. Kingshighway, St. Louis, Mo.
American Terra Cotta and Ceramic Co. (W. D. Gates, Pres.), 1808 Prairie Ave., Chicago, Ill.
American Trona Corporation (A. A. Holmes, Sales Mgr.), 233 Broadway, New York City.
Atlantic Terra Cotta Co. (William H. Powell, Pres.), 350 Madison Ave., New York City.
Auld Co., D. L. (F. Howard Auld), Fifth Street and Fifth Avenue, Columbus, Ohio.

The Babcock & Wilcox Co. (Isaac Harter, Gen. Supt.), 85 Liberty St., New York City.
Baker Bros. Glass Co. (W. G. Baker, Pres.), Okmulgee, Okla.
Batchelder-Wilson Co. (Ernest A. Batchelder), 2633 Artesian St., Los Angeles, Cal.
Bausch & Lomb Optical Co. (John C. Kurtz), Rochester, N. Y.
Beaver Falls Art Tile Co. (F. W. Walker, Jr.), Beaver Falls, Pa.
Benjamin Electric Mfg. Co. (A. E. Clarke), Des Plaines, Ill.
Big Savage Fire Brick Co. (D. A. Benson, Vice-Pres.), Frostburg, Md.
Bird & Co. (B. A. White), Kumardhubi Fireclay & Silica Wks. Ltd., Calcutta, India.
Bowman Coal Co. (Robert T. Bowman, Pres.), Broad St. Bank Bldg., Trenton, N. J.
Brick & Clay Record (E. G. Zorn), 407 S. Dearborn St., Chicago, Ill.
Brunner Mond & Co. Ltd. (L. A. Munro), Northwich, England.
Buckeye Clay Pot Co. (A. S. Zopfi), Toledo, Ohio.
Buffalo Pottery (L. H. Bown, Gen. Mgr.), Buffalo, N. Y.
W. G. Bush & Co. (W. H. Herbert), 174 Third Ave. North, Nashville, Tenn.

Canadian General Electric Co., Peterborough, Canada.
Canonsburg Pottery Co. (W. C. George), Canonsburg, Pa.

[1] *The name of the individual representative is given in parentheses after the name of the company.*

The Canton Brick & Fireproofing Co. (W. F. Demuth, Pres.), New Philadelphia, Ohio.
The Canton Stamping & Enameling Co. (E. F. Hoerger), Canton, Ohio.
The Carborundum Co. (Frank J. Tone), Niagara Falls, N. Y.
The Champion Porcelain Co. (Jos. A. Jeffery), Detroit, Mich.
Chicago Crucible Co. (A. F. Hottinger), 2525 Claybourn Ave., Chicago, Ill.
Chicago Pottery Co. (F. J. Clifford), 1924 Claybourn Ave., Chicago, Ill.
Chicago Retort and Fire Brick Co. (John H. Cavender, Vice-Pres.), 208 S. LaSalle St., Chicago, Ill.
The Clay Products Co. (Geo. W. Shoemaker, Vice-Pres.), Brazil, Ind.
Clay Service Corporation (M. E. Gates, Pres.), 138 N. LaSalle St., Chicago, Ill.
Claycraft Mining & Brick Co. (Wm. T. Mathews), 907 Hartman Bldg., Columbus, Ohio.
Clinchfield Products Corp. (Charles Ingram), 350 Madison Ave., New York City.
The Colonial Co. (Wm. H. Robinson, Sec.-Treas.), East Liverpool, Ohio.
Conkling-Armstrong Terra Cotta Co. (Thos. F. Armstrong, Pres.), 410 Denckla Bldg., Philadelphia, Pa.
Cook China Company (James Turner, Vice-Pres.), Trenton, N. J.
Coonley Mfg. Co. (T. A. McDonald), Cicero, Ill.
Cortland Grinding Wheels Corp. (E. Bertram Pike, Pres.), Chester, Mass.
Crescent Refractories Co. (R. F. Hess), Curwensville, Pa.
Crown Potteries Co. (A. Davidson, Sec.), Evansville, Ind.

Denny Renton Clay and Coal Co. (R. A. Swam, Gen. Mgr.), Pioneer Bldg., Seattle, Wash.
The Denver Terra Cotta Co. (Geo. P. Fackt, Vice-Pres.), West First and Umatilla Sts., Denver, Colo.
Dings Magnetic Separator Co. (R. A. Manegold), Milwaukee, Wis.
H. L. Dixon Co. (D. W. Loomis, Treas.), Box 140, Pittsburgh, Pa.
Joseph Dixon Crucible Co. (Malcolm McNaughton), Jersey City, N. J.
B. F. Drakenfeld & Co., Inc. (B. F. Drakenfeld, Jr.), 50 Murray St., New York City.
Dunn Wire Cut Lug Brick Co. (Frank B. Dunn), Conneaut, Ohio.

East Liverpool Potteries Co. (Bernard S. Purinton), Wellsville, Ohio.
The Edgar Plastic Kaolin Co. (D. R. Edgar), Metuchen, N. J.
Electric Porcelain & Mfg. Co. (Henry T. Paiste, Pres.), Trenton, N. J.
Electrical Refractories Co. (C. W. Williams, Treas.), East Palestine, Ohio.
Elgin Butler Brick and Tile Co. (John F. Butler, Pres.), Austin, Texas.
Elyria Enameled Products Co. (Wm. E. Gray), Elyria, Ohio.
Charles Engelhard, Inc. (R. N. Newcomb), 30 Church St., New York City.
English China Clays Sales Corp. (W. F. Harris, Treas.), 33 West 42nd St., New York City.
Enterprise White Clay Co. (H. S. Donaldson, Treas.), Real Estate Trust Bldg., Philadelphia, Pa.
Eureka Flint and Spar Co. (Frank W. Thropp), Trenton, N. J.

Federal Terra Cotta Co. (DeForest Grant, Pres.), 101 Park Ave., New York City.
Edward Ford Plate Glass Co. (C. E. Husted), Rossford, Ohio.
Fords Porcelain Works, (Abel Hansen, Pres.), Perth Amboy, N. J.
The French China Co. (Ernest Hundley), Sebring, Ohio.
Frink Pyrometer Co., Lancaster, Ohio.

General Ceramics Co. (Lewis Albrecht), 50 Church St., New York City.
W. S. George Pottery Co. (W. C. George), East Palestine, Ohio.
Gillinder Bros. (James Gillinder), Port Jervis, N. Y.
Gladding McBean & Co. (Atholl McBean, Sec.), Crocker Bldg., San Francisco, Cal.
Gleason-Tiebout Glass Co. (C. H. Tiebout, Jr.), 99 Commercial St., Brooklyn, N. Y.
Globe Brick Co., Box 765, East Liverpool, Ohio.
The Golding Sons Co. (J. M. Manor), East Liverpool, Ohio.
Golding-Keene Co. (Charles E. Golding), Keene, N. H.

The Haeger Potteries, Inc. (E. H. Haeger, Pres), Dundee, Ill.
The Hall China Co. (M. W. Thompson, Sec.-Treas.), East Liverpool, Ohio.
Hanovia Chemical and Mfg. Co. (W. Riehl), Chestnut St. and N. J. R. R. Ave., Newark, N. J.
Harbison-Walker Refractories Co. (Kenneth Seaver), Pittsburgh, Pa.
Hardinge Co., Inc. (Harlowe Hardinge, Vice-Pres.), 120 Broadway, New York City.
The Harker Pottery Co. (H. N. Harker), East Liverpool, Ohio.
The Harshaw, Fuller & Goodwin Co. (W. A. Harshaw), 545 Hanna Bldg., Cleveland, Ohio.
Hazel-Atlas Glass Co. (J. H. M. Nash), Wheeling, W. Va.
Heidenkamp Plate Glass Co. (Jos. Heidenkamp, Pres.), Springdale, Pa.
Homer-Laughlin China Co. (W. E. Wells), East Liverpool, Ohio.
L. J. Houze Convex Glass Co. (Roger J. Houze), Point Marion, Pa.
Huntington Tumbler Co. (E. L. Zihlman, Pres.), Huntington, W. Va.

Illinois Glass Co. (Ray S. Godard), Alton, Ill.
Ingram-Richardson Mfg. Co. (Ernest Richardson, Vice-Pres. and Treas.), Beaver Falls, Pa.
Iron City Sanitary Mfg. Co., 1514 Oliver Bldg., Pittsburgh, Pa.

Jefferson Glass Co. (C. H. Blumenauer, Pres.), Follansbee, W. Va.
Johnson Porter Clay Co. (Lance Turnbull), McKenzie, Tenn.
Jones Hollow Ware Co. (M. B. Meanley), Baltimore, Md.

O. W. Ketcham (O. W. Ketcham), 125 North 18th St., Philadelphia, Pa.
Kier Fire Brick Co. (P. S. Kier), 2243 Oliver Bldg., Pittsburgh, Pa.
Edwin M. Knowles China Co. (Harry Watkin), Newell, W. Va.
Knowles, Taylor & Knowles Co. (Homer J. Taylor), East Liverpool, Ohio.
Koken Companies (Geo. D. Chisholm, 1st Vice-Pres.), 2528 Texas Ave., St. Louis, Mo.

Laclede-Christy Clay Products Co. (John L. Green, Pres.), St. Louis, Mo.
The Libbey Glass Mfg. Co. (George Dougherty), Toledo, Ohio.
The Limoges China Co. (W. I. Gahris), Sebring, Ohio.
A. J. Lindemann & Hoverson Co. (W. C. Lindemann), Milwaukee, Wis.
Lindsay Light Co. (Jos. M. Sherburne), 161 E. Grand Ave., Chicago, Ill.
Livermore Fire Brick Works (N. A. Dickey, Gen. Mgr.), 604 Mission St., San Francisco, Cal.
Los Angeles Pressed Brick Co. (Howard Frost, Pres.), 6th Floor, Frost Bldg., Los Angeles, Cal.
The Louthan Manufacturing Co. (Wm. B. Louthan), East Liverpool, Ohio.

D. E. McNicol Pottery Co., East Liverpool, Ohio.
Macbeth-Evans Glass Co. (C. R. Peregrine), Pittsburgh, Pa.
John Maddock & Sons (H. E. Maddock, Vice-Pres.), Trenton, N. J.
Thomas Maddock's Sons Co. (C. S. Maddock, Jr.), Trenton, N. J.
Maine Feldspar Co. (Norman G. Smith), Auburn, Maine.
Mason City Brick and Tile Co. (B. C. Keeler), Mason City, Iowa.
Massillon Stone and Fire Brick Co. (T. C. Eayrs, Gen. Mgr.), Massillon, Ohio.
Matawan Tile Co. (B. K. Eskesen), Matawan, N. J.
Metal and Thermit Corp. (H. F. Staley), 120 Broadway, New York City.
Michigan Stove Co. (Emmet Dwyer), Detroit, Mich.
Midland Terra Cotta Co. (Walter S. Primley), 1515 Lumber Exch. Bldg., Chicago, Ill.
Millville Bottle Works (W. F. Wheaton), 7th and Main Sts., Millville, N. J.
Mississippi Glass Co. (R. D. Humphreys), 220 Fifth Ave., New York City.
Mitchell Clay Mfg. Co. (Wm. F. Knoesel), 5627 Manchester Ave., St. Louis, Mo.
The Mogadore Insulator Co. (F. W. Butler, Pres.), Mogadore, Ohio.
Monongah Glass Co. (R. T. Cunningham, Sec.-Treas.), Fairmont, W. Va.
Moore & Munger (Melville Marks), 29 Broadway, New York City.
The Mosaic Tile Co. (J. M. Morton), Zanesville, Ohio.
J. L. Mott Co. (W. J. J. Bowman, Gen. Works Mgr.), Trenton, N. J.

The National China Co. (Samuel B. Larkins, Sec.), Salineville, Ohio.
National Fireproofing Co. (W. H. Foster), 1126 Fulton Bldg., Pittsburgh, Pa.
National Lime Association (M. E. Holmes), 918 G Street N. W., Washington, D. C.
New York Architectural Terra Cotta Co. (R. F. Dalton, Pres.), 401 Vernon Ave., Long Island City, N. Y.
Niles Fire Brick Co. (P. J. Sheehan), 165 East Park Ave., Niles, Ohio.
Nippon Gaishi Kwaisha (M. Ezoi, Mgr.), Atsuta Higashimatch, Nagoya City, Japan.
Nippon Toki Kwaisha (M. Ise, Mgr.), Noritake, Nagoya City, Japan.
North Carolina Geological and Economic Survey (Joseph Hyde Pratt, Director), Chapel Hill, N. C.
Norton Co. (Arthur T. Malm), Worcester, Mass.

Ohio Pottery Co. (C. D. Fraunfelter), Zanesville, Ohio.
Old Bridge Enameled Brick & Tile Co. (Hamilton Hazlehurst), Old Bridge, N. J.
The Onondaga Pottery Co. (B. E. Salisbury), Syracuse, N. Y.
Owen China Co. (F. B. Cross), Minerva, Ohio.

Paper Makers Importing Co., Inc. (Charles Brian, Vice-Pres.), 640 N. 13th St., Easton, Pa.
Parker Russell Mining & Mfg. Co. (Lemon Parker), 603 Laclede Gas Bldg., St. Louis, Mo.
Pass & Seymour, Inc. (B. E. Salisbury), Solvay, N. Y.
The Patterson Fdry. & Mch. Co. (Richard L. Cawood, Pres.), East Liverpool, Ohio.
Pennsylvania Pulverizing Co. (Wm. J. Woods), Lewistown, Pa.
Pennsylvania Salt Mfg. Co., 615 Union Arcade Bldg., Pittsburgh, Pa.
Perth Amboy Tile Co. (C. H. Rasmussen), Perth Amboy, N. J.
The Pfaudler Co. (N. G. Williams), Rochester, N. Y.
Philadelphia Drying Machinery Co. (Walter W. Sibson), Philadelphia, Pa.
Phoenix Glass Co. (A. H. Stewart), Pittsburgh, Pa.
Pittsburgh High Voltage Insulator Co. (W. H. Lowry), Derry, Pa.
The Pittsburgh Plate Glass Co. (C. E. Fulton), Pittsburgh, Pa.
The Pope-Gosser China Co. (G. C. Mitchell, Pres.), Coshocton, Ohio.
The Porcelain Enamel and Mfg. Co. (Karl Türk, Vice-Pres.), O'Donnell and Eighth Sts., Baltimore, Md.
Portland Stove Works (Harry A. Montag), Portland, Ore.
The Portsmouth Stove and Range Co. (John B. Krauss, Vice-Pres.), Portsmouth, Ohio.
Potters Supply Co. (Dewitt C. Irwin), East Liverpool, Ohio
Proctor & Schwartz, Inc. (E. B. Ayres, 2nd Vice-Pres.), 7th St. and Tabor Rd., Philadelphia, Pa.
The Product Sales Co. (Joseph Rodgers), 206 Water St., Baltimore, Md.

Reading Firebrick Works, Reading, Pa.
Reliance Firebrick and Pottery Co. Ltd., 8 Clive Row, Calcutta, India.
Robertson Art Tile Co. (A. D. Forst, Pres.), Box 848, Trenton, N. J.
Roessler & Hasslacher Chemical Co. (Werner Malsch), 709–717 Sixth Ave., New York City.
The Rookwood Pottery Co. (Stanley G. Burt), Mount Adams, Cincinnati, Ohio.
Russell Engineering Co. (A. W. Buckingham), 1624 Railway Exchange Bldg., St. Louis, Mo.

Salem China Co. (F. H. Sebring), Salem, Ohio.
The John Sant & Sons Co. (Thos. H. Sant, Pres.), East Liverpool, Ohio.
The Saxon China Co. (Ray Y. Cliff, Treas. and Gen. Mgr.), Sebring, Ohio.
Schaffer Engineering & Equipment Co. (A. A. Alles, Jr.), 2828 Smallman St., Pittsburgh, Pa.
Seaboard Fuel Corp. (Geo. W. Dilks, Jr., Vice-Pres.), 1610 Spruce St., Philadelphia, Pa.
The Sebring Pottery Co. (Charles L. Sebring), Sebring, Ohio.
Smith-Phillips China Co. (W. H. Phillips), East Liverpool, Ohio.
South Amboy Terra Cotta Co. (Peter C. Olsen), 150 Nassau St., New York City.
The H. C. Spinks Clay Co., Newport, Ky.
Springfield Paving Brick Co. (W. P. Whitney, Pres.), Box 403, Springfield, Ill.
Square D Company (A. P. Ball, Asst. Gen. Mgr.), Peru Plant, Peru, Ind.
Standard Pottery Co. (D. M. Cronin), East Liverpool, Ohio.
Standard Sanitary Mfg. Co. (G. C. Kalbfleisch), Tiffin Works, Tiffin, Ohio.
Standard Sanitary Mfg. Co. (Theodore Tafel, Jr.), 551 Preble Ave., N. S., Pittsburgh, Pa.
Star Porcelain Co. (Herbert Sinclair), Trenton, N. J.
The Stark Rolling Mill Co. (R. B. Dimmick), Canton, Ohio.
Stevens Bros. & Co. (W. S. Stapler, Pres.), Stevens Pottery, Ga.
St. Louis Terra Cotta Co. (R. F. Grady), 5811 Manchester Ave., St. Louis, Mo.
Stockton Fire Brick Co. (John T. Roberts), 915 Rialto Bldg., San Francisco, Cal.
Streator Clay Mfg. Co., Streator, Ill.
The Strong Manufacturing Co. (W. U. Pfaeffli, Treas. and Gen. Mgr.), Sebring, Ohio.
Sunflower Glass Co. (Frank Bostock, Pres.), Sapulpa, Okla.

The Taylor, Smith & Taylor Co. (W. L. Smith, Jr.), Chester, W. Va.
R. Thomas & Sons Co. (G. Richard Thomas), East Liverpool, Ohio.

Toyo Toki Kwaisha (S. Momoki), Shinozaki, Kokura City, Japan.
Trenton Flint & Spar Co. (R. H. Wainford), 203 East State Street, Trenton, N. J.
Trenton Potteries Co. (John A. Campbell, Pres.), Trenton, N. J.
Tropico Potteries Inc. (F. B. Ortman, Vice-Pres.), Glendale, Cal.
W. S. Tyler Co., (F. P. Nickerson), Cleveland, Ohio.

U. S. Glass Co. (G. Oliver Challinor), South Ninth Street, Pittsburgh, Pa.
U. S. Metals Refining Co. (Francis R. Pyne), Chrome, N. J.
U. S. Smelting Furnace Co. (Walt Marsh), Belleville, Ill.
Universal Clay Products Co. (Frank E. Pyatt), Sandusky, Ohio.
Universal Sanitary Mfg. Co. (C. J. Kirk, Pres.), New Castle, Pa.

Veritas Firing System (Herbert Forester), Prospect Laboratories, Trenton, N. J.
The Vitreous Enameling Co. (R. D. Landrum, Vice-Pres.), Cleveland, Ohio.
Vitro Manufacturing Co. (Josef Vollkommer), Bessemer Bldg., Pittsburgh, Pa.
Vodrey Pottery Co. (Wm. E. Vodrey), East Liverpool, Ohio.
The Vollrath Co. (Dewitt F. Riess, Sec.), Sheboygan, Wis.

The Wahl Co. (Robert Back), 1800 Roscoe St., Chicago, Ill.
Wainford Darling Co. (C. Harry Darling, Pres.), Trenton, N. J.
Warwick China Co. (C. E. Jackson), Wheeling, W. Va.
The Wehrle Co. (W. W. Wehrle), Newark, Ohio.
The West End Pottery Co. (W. E. Cunning, Pres.), East Liverpool, Ohio.
Western Electric Co. (W. F. Horford, Technical Supt.), Hawthorne Sta., Chicago, Ill.
Western Stoneware Co. (I. F. Dains), Monmouth, Ill.
Whitall-Tatum Co. (Geo. S. Bacon), Millville, N. J.
Whiting-Mead Commercial Co. (W. H. Mead, Vice-Pres.), 2035 E. Vernon Ave., Los Angeles, Cal.
H. R. Wyllie China Co. (H. R. Wyllie), Huntington, W. Va.

THE AMERICAN CERAMIC INDUSTRIES

By F. H. Riddle[1]

Definition of the Term "Ceramics"

The term "Ceramics" has a much more definite meaning now than it did when the Society was founded twenty-five years ago. It is gratifying to most of us to know that the members of our Society have played an important part in bringing about this condition. Most of us are familiar with the definition of the word ceramics but it is not out of place to repeat it at this time.

The dictionary definition as reviewed by our Committee on the definition of the term first appeared in the English language about the middle of the 19th century, apparently through adoption from the French (Fr. *ceramique*). In accordance with modern language usage, as known by the lexicographers, the term "ceramics" is employed to designate that portion of the plastic arts which embraces the production and decoration of all objects formed by the molding, modeling and baking of clay. According to lexicographers the term is, therefore, practically synonymous with the clay working of the art of the potter, and there is no indication in any of the dictionary definitions, of a broader significance than this.

The Committee further states that the term "ceramics" as used in modern technology, has acquired, at all events in this country, a much wider significance than that indicated by the dictionary definition. They state further "..... we may, therefore, properly define and describe the ceramic industries as those industries which manufacture products by the action of heat on raw materials, most of which are of an earthy nature, while of the constituents of these raw materials the chemical element, silicon, together with its oxide and the compounds thereof (silicates), occupies a predominant position." In accordance with this definition we may enumerate among the products of the ceramic industries the following: Their list includes burned clay products, cementing materials, glass, enameled metal, refractory materials, abrasives and electrical and thermal insulating products in the manufacture of which clay enters in as an important element. Oldfather's article[2] on the word "ceramics" is interesting in the above connection.

In the September issue of this *Journal* is published the report of the Committee on an International Definition of the term "Ceramic," as given by Dr. E. W. Washburn, the American Ceramic Society's representative, at the Third Conference of the International Union of Pure and Applied Chemistry, held at Lyons, France, on June 27 to July 2, 1921. The report is as follows:

[1] Read before the Chemical Exposition, New York City, September, 1922.

[2] *Jour. Amer. Ceram. Soc.*, 3 [7], 537.

The committee had before it an excellent French translation of the report of the AMERICAN CERAMIC SOCIETY'S committee on definition of the term "ceramic." This report was printed and placed in the hands of all the delegates in attendance at Lyons. The committee approved unanimously the recommendations contained in this report and voted that it serve as the basis of discussion of the question which should be brought before the next meeting of the Union for final consideration, after each country belonging to the Union had had an opportunity to study the report and contribute to the discussion.

Ceramic Industries

The following outline shows briefly the various products which are classed as ceramic materials: (1) Clay products (exclusive of refractories), (2) glass, (3) enameled metal, (4) abrasives and (5) refractories. Some also believe that the production of cement and lime would come under the same headings.

Clay Products

Porcelain, whiteware and kindred products

- Hotel china and vitrified tableware
- Whiteware or semi-vitreous tableware
- Floor and wall tile
- Electrical porcelain
- Specialties, as spark plug porcelain, etc.
- Chemical porcelain
- Refractory porcelain, such as pyrometer protection tubes
- Chemical stoneware
- Stoneware
- Yellowware
- Art pottery

Hollow ware

- Sewer pipe
- Partition tile
- Drain tile

Terra cotta for building purposes

Brick

- Common brick
- Face brick
- Fire brick (see refractories)
- Paving brick

Glass

Building glass

- Window glass, plate glass, cast and rolled glass

Pressed and blown glass

Tableware, jelly glasses, tumblers, goblets, bar goods, lamps, chimneys, lantern globes, electric globes, electric bulbs, shades, globes, opal ware, art ware, decorated glassware

Bottles, jars, druggists' ware, demijohns, etc.

Enameled Metal

Sanitary ware, bath tubs, wash-stands, etc.

Cooking ware, enameled pans, etc.

Chemical ware, vats, stills, etc.

Abrasives

Materials such as silicon carbide, alundum, emery, and other products together with the products manufactured from them by the bonding with an earthy material.

Refractories

Ground refractories as fire clay, chrome, magnesite, etc.

Brick

Clay, magnesite, silica, chrome, alundum, silicon carbide, spinel, sillimanite, etc.

Blocks, glass pots and special refractories

Ceramic products play a wider rôle in building and construction than do any other products with the possible exception of steel.

Value of the Products

An attempt has been made to show the value of these products. However, since the reports are for the year 1919–20, it must be remembered that these years were not normal. The increase in the value of clay products since 1915 has been largely due to the increase in price, although most of the products have increased in quantity also. During 1918 pottery was the only clay product which was not restricted. Products for building purposes were severely restricted in output during the World War; however, the increase in building activities during 1920 caused large increases in the output of clay products for this purpose with the exception of fire brick which showed a decrease. This was due not only to the strike in the steel industry, its chief consumer, but also on account of the abnormal demand during the War. In the glass industry the increase from 1914 to 1919 is also due to increases in value on account of wartime conditions.

Abrasives showed a decline after the War on account of the depression in the steel and metal manufacturing lines.

The values of the products manufactured during 1920, unless otherwise marked, as given by various government reports are as follows:

Clay products (exclusive of refractories)	$320,254,214.00
Glass, 1919	261,884,080.00
Enameled metal	42,559,569.00
Abrasives (natural, artificial and manufactured)	44,971,343.00
Refractories	53,415,888.00
Total	$723,085,094.00

A detailed list of some of the ceramic products is of interest.

Clay products (including refractories)	
Porcelain pottery, etc.	
Red earthenware	$1,766,919.00
Red and brown white-lined cooking ware	715,902.00
Stoneware and yellow and Rockingham ware	5,475,660.00
Chemical stoneware and porcelain	1,273,511.00
White ware, including C. C. ware, etc.	38,323,880.00
China, bone china, Delft and Belleek ware	11,340,093.00
Sanitary ware	22,014,651.00
Porcelain electrical supplies	20,218,924.00
Miscellaneous	5,587,136.00
Total	$106,716,676.00
Terra Cotta (architectural)	$10,851,902.00
Hollow ware	
Sewer pipe	$25,171,015.00
Tile	12,470,036.00
Drain tile	12,524,641.00
Building tile	27,312,007.00
Total	$77,477,699.00
Brick	
Common brick	$82,216,230.00
Face and fancy brick	20,552,372.00
Paving and vitrified brick	12,678,557.00
Fire brick	53,415,888.00
Miscellaneous	9,524,336.00
Total	$266,953,426.00
Glass, 1919	
Building glass	$83,713,115.00
Pressed and blown glass	70,748,861.00
Bottles and jars	94,670,389.00
Other products	12,751,715.00
Total	$261,884,080.00

Enameled Metal	
Enameled ware	$37,636,584.00
Bath tubs	2,955,953.00
Lavatories and sinks	1,967,032.00
Total	$42,559,569.00
Abrasives	
Artificial	$7,492,164.00
Natural	4,299,812.00
Emery and other abrasive wheels	30,949,270.00
Grindstones	1,369,423.00
Millstones	66,896.00
Hones and whetstones	793,778.00
Total	$44,971,343.00

A glance at the above list gives one an idea of the enormous value of the product manufactured every year in the United States and the diversified interests that are dependent upon ceramic products for many of the essentials of their business.

Possibly the most important ceramic products from a manufacturing standpoint are refractories, and, unfortunately, the product that the consumer pays very little attention to. Every power house is dependent upon the fire brick in their boilers for continuation of uninterrupted service and yet the smaller users are very apt to buy these brick upon a price consideration only, assuming that all so-called fire brick are equally good.

Growth of the Industry

The growth of the industry is probably best shown by a study of the various government reports, as plotted on curves shown in Figs. 1 and 2.

Clay Described

Practically all branches of the ceramic industry involve the use of clay as a raw material so that, on account of its importance in this respect, a description of clay is of interest.

Briefly, pure clay is a hydrated aluminum silicate of the formula—Al_2O_3, $2SiO_2$, $2H_2O$—having a chemical composition by per cent of

46.5% Silica
39.6% Alumina
13.9% Water

This pure material is spoken of as kaolin; however, the large bulk of clays are very impure and only good for manufacturing lower grades of heavier clay products. From the industrial standpoint clays may be divided into several classes. These are given by Bleininger as follows:

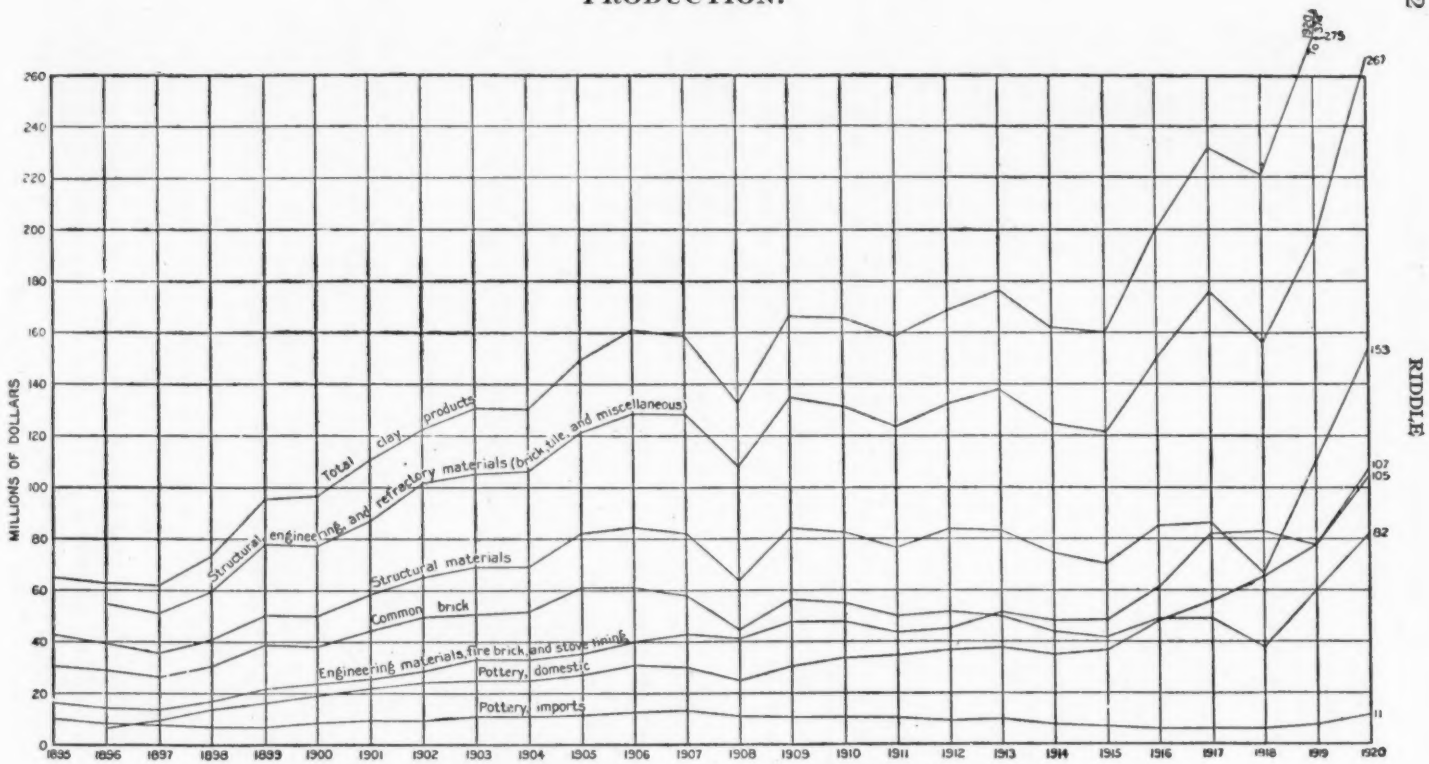


FIG. 1.—Value of clay products sold in the United States, 1895–1920.
(From Report of the United States Geological Survey.)

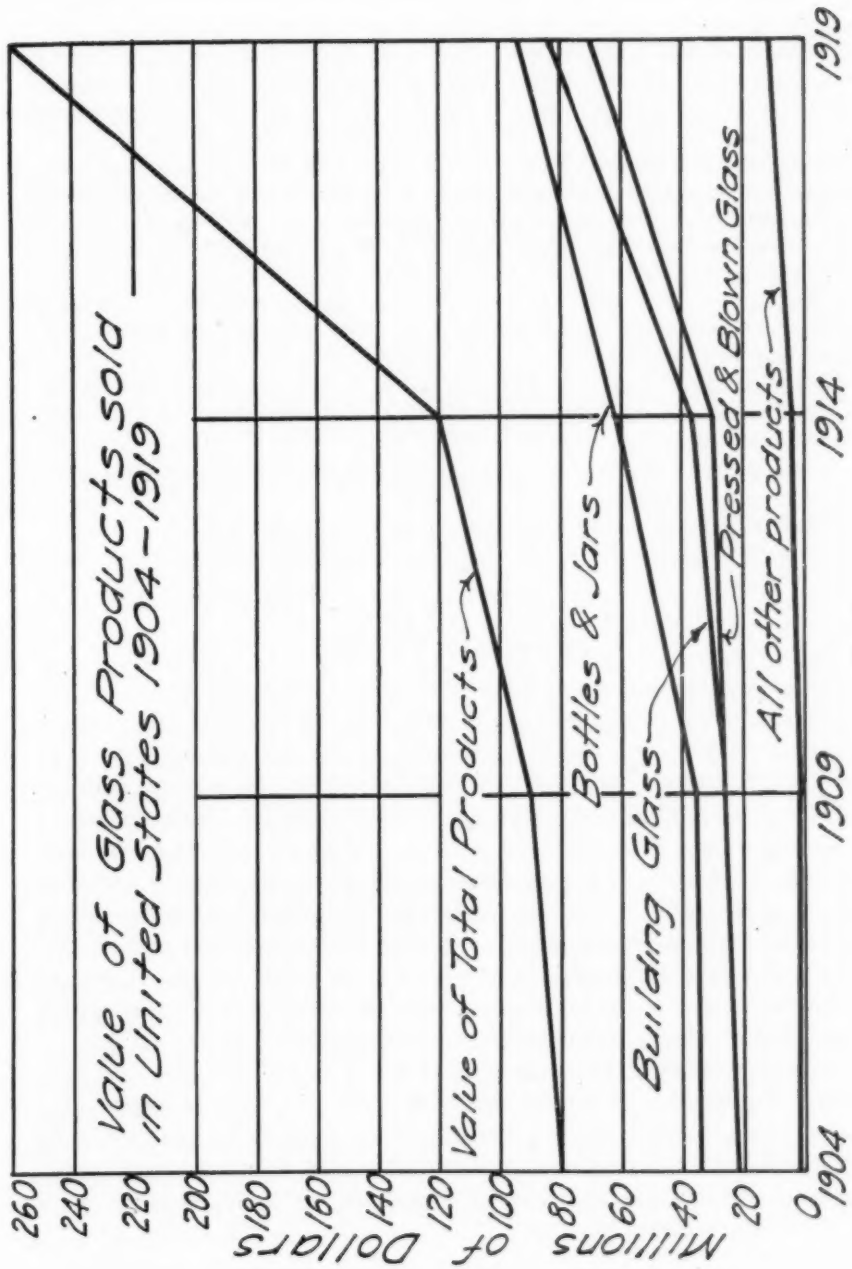

Value of Glass Products sold in United States 1904–1919
Millions of Dollars
260
240
220
200
180
160
140
120
100
80
60
40
20
0
1904
1909
1914
1919
Value of Total Products
Bottles & Jars
Building Glass
Pressed & Blown Glass
All other products

FIG. 2.

1. Primary Kaolins.—Usually white burning, very refractory, and of low plasticity and strength.

2. Plastic Kaolins.—Not as white burning as primary clays. May be very plastic.

3. Clays of the Fire-clay Type.—Ranging from materials of high refractoriness to those inferior in this respect. Certain highly refractory clays called flint clays, are almost lacking in plasticity. Very plastic clays, called ball or bond clays.

4. Shales.—Fine-grained, hard clays, showing well-defined cleavage and often slate-like in appearance. They differ widely as to composition. Many ferruginous shales are sources of the best paving brick. Shales, as a rule, are uniform over comparatively large areas, and hence have great industrial importance.

5. Alluvial Clays.—Of recent geological origin and found principally in old and new river valleys. Vary widely in composition and physical behavior, from clays of excellent plasticity to very sandy materials. As a rule, unsuitable for paving brick. Usually burn to a red color.

6. Glacial Clays.—Heterogeneous mixtures of clay with various rock debris. Frequently calcareous, causing clay to burn to a cream or buff color. As a class difficult to work and hence suitable only for crude products.

7. Loess Clays.—Wind-blown deposits, usually siliceous and hence of low plasticity. Used only for common bricks.

The United States is not deficient in any of the types of clay, although the distribution, of course, is not uniform, so that many states are lacking entirely in certain kinds of raw material.

Standards for Purchase

Considerable work has been done by the various technical societies in the country to develop suitable specifications for the purchase of ceramic materials. Perhaps the American Society for Testing Materials has done more than any other group. The several branches of the ceramic industry have established Trade Associations or similar organizations and these have done a great deal along the same line. Considerable research work has also been done by these organizations; however, this will be mentioned later. Secretary Hoover has accomplished a great deal in his recent moves to standardize and simplify products and he has received the enthusiastic coöperation of the ceramic manufacturers. A great deal has been accomplished in the paving brick industry by the elimination of many special shapes and by the standardization of the necessary shapes.

Many laboratories, government bureaus, technical societies and consumers have worked on the standard tests and specifications for the purchase and use of refractories and have developed standards that are satisfactory to both the consumer and manufacturer; however, many small consumers do not see the necessity of undertaking these tests and quite often get into serious difficulty.

President C. D. Young in his Annual Address to the American Society for Testing Materials in June, 1922, made some very pertinent remarks which should not be lost sight of.

He states:

In overcoming the prejudice against standardization, the manufacturer has learned that it is possible for him to produce a far better quality of product, and at the same time greatly reduce his expenses through mass production. This lower cost makes it possible not only to offer to the public better materials at lower unit prices, but also to maintain at the same time higher wages for labor.

Although standardization restricts the varieties for selection, it permits concentration of thought and skill upon design, so that the product may be more economically and efficiently handled. It also reduces the maintenance cost of the finished structure by simplifying the stocks necessary for their maintenance. These well-established standards have established that factor of safety which is essential for the engineer in making the finished product.

American standards of quality, having forced recognition throughout the world, have stabilized production and employment through the broadening effect of increased markets, and have made it safe for manufacturers to accumulate stocks during dull periods, when, without such standards, such a policy would have been extremely hazardous not only to the manufacturer but also to the general public.

Industries Described

The Pottery Industry in the United States includes several types such as stoneware, majolica, whiteware and porcelain. For a time it looked as if the old-fashioned stoneware, such as butter jars, jugs, etc., was becoming extinct; however, this industry has again become active as many homes are finding use for the ten and twenty gallon crocks. The chemical stoneware industry has developed to an extensive degree since the outbreak of the War and has made this country independent of importation. Very difficult shapes are manufactured, such as complete condensing coils; large pieces, such as 1,000 gallon covered jars are also made.

Most of the tableware produced in America is either whiteware or porcelain. The whiteware is porous and opaque although a good white, while the porcelain is a slightly bluer white, vitreous, impervious to liquids and partially translucent. Whiteware is divided into several classes dependent more or less upon the amount of porosity ranging all the way from four to ten per cent absorption. The best grade is known as "white granite."

Bodies of this type are produced from a mixture of kaolin, ball clay and ground feldspar and potter's flint or quartz. Feldspar melts when the body is heated and acts as a binder to cement the rest of the materials together. Vitreous porcelain not only contains slightly more of the feldspar or glass forming material but it is also burned to a higher temperature, so that the available feldspar becomes glassier and is able to bond better.

In the manufacture of whiteware the body, after forming, is first burned to about 1290°C. This is the bisque burn. The ware is then glazed and burned in the glost fire at about 1190°C. English practice is to use a glaze

that melts properly on the body at about 1120°C, thus making the English ware softer. The usual composition for the whiteware body is kaolin or china clay 35%, ball clay 15%, feldspar 15% and flint 35%.

The composition of American porcelain is about 45% of clays, 20% feldspar, 35% flint. Ware made from this body is burned to 1330°C in the bisque burn at which point it becomes very dense and vitreous. The glazing is done similar to whiteware.

The European practice is to burn the ware to a low bisque temperature, about 990°C, and then burn the glazed ware up to the vitrifying temperature about 1410°C. This produces a hard, vitreous, translucent body. The glaze is very hard, being free from the fluxes, such as lead and boric acid. It also has a fine opportunity to become soft and stick more closely to the bisque body.

True, hard-fire porcelain is not manufactured in America to any great extent; however, the chemical porcelain industry has grown enough since the War to make us independent of importation. Pyrometer Protection Tubes were made before the War by the Royal Porcelain Manufactory. This process was worked out in the States by the Ceramic Department at the Bureau of Standards at Pittsburgh, Pa., and the product is now being manufactured here by several firms.

Electrical porcelain usually has a composition about 50% kaolin and ball clay, 30% feldspar and 20% ground quartz or flint. This material is fired once only, the glaze being put on the green or dried unfired piece. This makes a very close union between the glaze and body. The burning temperature is approximately 1330°C. This body must be free from flaws of all sorts as it is subject to both mechanical and electrical strains at all times. Each piece of ware made must be tested before leaving the factory.

Porcelain for spark plugs must withstand high current at increased temperatures and this has led to the development of special porcelains. Internal combustion engines operate at temperatures as high as 950°C, while the ordinary porcelain becomes a conductor at about 400°C, making its use prohibitive. The Bureau of Standards and manufacturers have worked on this problem with considerable success and developed porcelains free from alkali fluxes and undissolved silica, both of which are objectionable, the former from a hot dielectric standpoint and the latter from a physical standpoint.

Plumbing supplies and sanitary ware must be made of vitreous porcelain; however, bath tubs and some of the larger pieces are made of a porous fire clay body, this being covered with a white vitreous coating and glaze.

Some very high grade work has been done in the United States in the manufacture of art pottery. Rookwood Pottery, made in Cincinnati, has made an international reputation having developed several distinct types of beautiful ware. The Onondaga Pottery Company of Syracuse,

N. Y., has done exceptional work in the development of high grade hotel china.

Lenox, Incorporated, of Trenton, N. J., is making a high grade Belleek ware. This is a beautiful vitreous translucent, cream colored ware which lends itself well to the use of golds and other types of decoration.

The Ohio Pottery Company of Zanesville, Ohio, should be complimented upon the excellent tableware it is making by the European method of burning, the first time to a low temperature and then glazing and maturing the ware at the final high temperature in the second burn. Many others are doing excellent work and the interest developed along lines of this sort is steadily growing.

Vitrified porcelain floor tile are being used extensively in all sorts of building while the use of glazed wall tile is increasing more and more. The necessity for increasing the amount of reflected light and the demand for more sanitary conditions have brought this about.

Hollow Ware.—Ware of this character is made out of the more common clays, such as shale, low grade fire clay, stoneware clays, etc. The sewer pipe business is well established and more or less dependent upon the growth of cities and villages. The development of scientific farming has brought about an increased demand for drain tile. Partition tile has done a great deal towards the development of certain types of construction and the growing demand will continue to call for an increase in its manufacture.

Architectural Terra Cotta and Tile.—The use of architectural terra cotta has developed in America until it is practically universally used on all large buildings. Its advantages over cut stone are many. It resists all sorts of weather conditions, and is fire-proof, strong, light and easily erected, as well as being much lower in cost. Its decorative possibilities are great as it can be modeled as desired and given any color or texture. The skyline of any city may be said to be a characteristic combination of steel and terra cotta. Terra cotta is also being used extensively for interior decoration.

Brick.—Common brick need not be mentioned here. Their use is too well-known.

Developments have been made in the face brick business that have brought about architectural treatments in construction which could not have been attempted a few years ago.

Paving blocks are used extensively for road construction and one of their chief advantages over other forms of construction is that of the prevention of skidding during wet weather. The success of a brick pavement depends upon the method of construction, great care being required to secure a proper concrete foundation.

Glass.—The glass industry is much more extensive than is usually realized. No matter what type of construction is used, any building must

have windows and this together with the increased demand due to modern factory construction has brought about a prosperous condition among glass manufacturers.

The development of and demand for automobiles has also enormously increased the demand for high grade glass and this demand is growing still more rapidly on account of the greater demand for closed cars. The demand for headlight lenses is also extensive.

A modern glass factory is probably as well developed and equipped as any type of factory. On account of the heavy production and expensive equipment required for any particular glass product, most plants are large and devote their entire energy to only one type of product. This trend towards quantity production has gradually eliminated the glass blower and replaced him with machinery.

Where glass used to be melted in small pots, holding a ton, it is now melted in large tanks as much as 90 to 120 feet long and 20 to 25 feet wide, the molten glass being three or more feet deep. These tanks are arranged so that the materials of which the glass is made are put in at one end of the tank, melted, and run down to the other end where the molten, fined glass is drawn off or gathered and molded or drawn into shape.

The old method of making window glass was to have a man gather a quantity on a hollow rod and blow it into a long cylinder. The size of the cylinder depended upon the gatherer who stood on a platform, holding the rod vertical with the glass on the lower end, then swinging the rod and glass like a pendulum as he blew. The glass, instead of forming like a soap-bubble, would lengthen out into a long egg-shaped ball which would be rolled against a flat surface and gradually shaped into a cylinder with rounded ends. When of proper size, this would be cooled and the ends cut off, leaving a sheet glass tube usually about eighteen inches in diameter and five feet long. While still warm this tube would be cut once lengthwise and placed on its side in a furnace on a large flat stone, the furnace being warm enough to slowly soften the glass. The operator instead of allowing the glass to collapse as it softened would see that the lateral cut was placed on top and would unroll the cylinder by means of a long pole so that as it became softer it would gradually flatten out into a sheet of glass the full length of the cylinder and the width of the circumference. At the right stage the operator would then take a flattening iron and iron out all rough parts of the glass. To do this it was essential that the flattening stone beneath be perfectly planed. The sheet of glass would then be pushed out on to a conveyor, which would carry it through a furnace which gradually cooled off so that the glass was cool and could be handled at the exit end where it would be cut to size, inspected and packed.

The modern method permits of the gathering of the glass in a continuous sheet, running it over rolls until cool enough to put it into the leer or cooling

and annealing tunnel, passing it through the same, sizing, inspecting and packing it. The increase in production, uniformity of product, opportunities for control, etc., are obvious.

In the manufacture of hollow ware, the Owens machine and similar equipment have brought about developments that were unthought of a few years ago.

Art glass has been developed to a high degree and is worthy of mention. The Tiffany Favril glass is well-known by everyone. The artistic side of the lighting fixture glass ware industry has also been brought to a point where interior decoration schemes can be carried out with the lights as well as the hangings, and at a price that makes it possible in reasonably priced buildings.

Enameled Steel and Iron.—We are all familiar with the extent to which these products are used, at least so far as they are used in plumbing supplies and cooking ware manufacture; however, a good many of us do not realize the extent to which the enamel is used in the manufacture of gas stoves, refrigerator linings, soda fountain and restaurant equipment, kitchen table tops, steel thermos bottle linings, street signs, automobile license plates, etc. These are all things we see every day. Among the things we do not see that are enameled are the vats, tanks, pressure cookers and other equipment of this sort used in the manufacture of many products such as soft drinks, candies, toilet goods, etc. The development of chemical enameled ware has been perfected after extensive research work by the enamelers. Special enamels suitable for electrical insulation purposes have recently been developed. These are being used in resistors, electrical heaters and in similar equipment and no doubt the uses will be much greater as time goes on.

The development of an enamel of this character for automobile bodies would be a development worth consideration from the standpoint of the owner but the problems to be met by the manufacturer would be tremendous. The present baked enamels used in automobile work are put on at temperatures below red heat, but enamels of the type used in fused enamel work require temperatures well above red heat.

The enameling of jewelry, watch dials, etc., is an industry of considerable size.

The process of enameling iron appears to be very simple but requires great care, attention to detail and experience. The previously cleaned steel or iron piece which it is desired to enamel is heated red hot, drawn from the furnace, coated with a layer of finely ground glass or enamel, again inserted into the furnace until the glass has smoothed out, and then withdrawn and cooled. Sometimes the enamel coat is put on the piece before heating and usually several coats are applied. The price of a cooking utensil will vary with the number of coats of enamel, the color, etc. The kind of metal to

use, different kinds of enamel, as slush or first coat, and second coat, and proper temperature for best fusing the enamel to the iron without overburning, are all important points. The thermal coefficient of expansion of the enamel must be the same as that of the iron to prevent its chipping off, fish scaling, when subjected to changes in temperature or to impact.

Abrasives.—Most abrasives are artificial and manufactured by fusing or sintering raw materials together in an electric arc. These synthetic materials are later crushed and bonded together and formed into useful articles. Alundum is made by driving off the silica from bauxite leaving the fused alumina. Silicon carbide is made by chemically combining coke dust and sand in an electric arc.

These and similar products are ground to the proper grain size. This grain size depends upon the character of the finished product desired. Coarse grained and fine grained grinding wheels, of course, would be made of grains best suited for the particular purpose. The grains are mixed with ceramic bonds, usually clays, feldspars and the like and tamped into molds of the desired shape. When dry the wheels are placed in kilns very similar to a down-draft brick kiln and burned to a temperature sufficient to fuse the bond and hold the grains together. This temperature is around 1200°C but varies with the type of bond, character of grain, etc.

Refractories.—Refractories are used in practically all branches of manufacture, particularly in the metallurgical arts, clay, glass and cement industries as well as in the generation of steam. The most important types of refractories are clay, silica and magnesite.

(1) *Clay Refractories.*—Refractory clays are generally divided into three classes, *i. e.*, No. 1, No. 2, and No. 3, the grade depending upon the degree of refractoriness. Ware made from these clays will be classed approximately the same as the clays.

Kaolinite, the purest form of clay, has a melting point of approximately 1755°C. Usually clays are contaminated with some impurities which lower the melting point. On the other hand some clays contain more alumina than the theoretical amount for kaolinite. These usually contain some bauxite and they may raise the melting point up as high as 1800°C. Usually clays melting above 1685°C are classed as number one, those melting below this but above 1635°C as number two and those below that as number three.

Fire clays are also divided according to their silica content. Siliceous clays have a content of over 75% SiO_2 and are not as refractory as the less siliceous clays but have other good qualities, being less subject to shrinkage after being made into brick and subjected to long usage. They will stand up in use to temperatures approaching their fusion point while the lower silica content brick cannot be carried to temperatures within 150°C below their deformation point.

(2) *Silica Refractories.*—These are principally produced from ground quartzite being bonded with about 2% of lime paste. In manufacturing, products of this character must be burned to 1500°C. During the burning the quartz is transformed to cristobalite, an intermediate crystalline modification of silica. Considerable expansion takes place during this burning. With continued use at high temperatures part of the cristobalite transforms into tridymite. Silica brick do not soften much below their fusing point and can be used with safety under load at 1600°C. Unfortunately they do not stand up well under conditions of sudden heating and cooling, particularly if cooled to under 600°C.

(3) *Aluminous Refractories.*—These are usually made up of mixtures of clay and bauxite and have been found capable, in some instances, of replacing magnesite brick. Bauxites melt at around 1800 to 1820°C but have extremely high shrinkage making it necessary to previously calcine the material to have a good product.

(4) *Magnesia Refractories.*—The melting point of pure magnesia is about 2800°C. The pure material shrinks about 50% so that it is necessary to use grades containing iron or some other flux in order to produce products of the proper density. Brick made of magnesite are very valuable on account of their basic nature and high heat resistant qualities.

(5) *Other Refractories.*—Silicon carbide refractories have proved very useful under special conditions. This material, although it oxidizes readily particularly at lower temperatures, is capable of standing up under load at higher temperatures than most other refractories. It also has a high thermal conductivity which makes it very useful for muffles and other types of construction where heat transfer is requisite.

Zircon or zirconium silicate and zirconia have also proved of value as refractories at high temperatures under special conditions but the manufacture has not been developed to any great degree.

Refractories for glass house use have been well developed and play an important part in the manufacture of glass.

Progress of Ceramic Work during the War

Like all other industries, the ceramic industry found the lack of importation was a serious handicap during the War. This was also realized by some consumers of ceramic products when they were unable to buy abroad. As in other cases this lack created a demand and willingness to pay on the part of the consumer that inspired the manufacturers to develop the old products or create substitutes. The necessities of the War also inspired those interested in the technical side of the questions and brought about a coöperation that, at least in the ceramic industries, bids well to continue.

Optical Glass.—Optical glass, the total supply of which had been

manufactured abroad, particularly in Germany, was probably the most sought for ceramic product. The study of the melting of optical glass was begun by the Bureau of Standards on a laboratory scale in 1914 and the manufacture of it as early as 1912 by the Bausch and Lomb Optical Company of Rochester, New York; in 1915 by the Keuffel and Esser Company, Hoboken, New Jersey, and the Pittsburgh Plate Glass Company, Pittsburgh, Pa., and in 1916 by the Spencer Lens Company of Buffalo, New York. The Bureau of Standards built a small glass plate in Pittsburgh in 1917 and later a larger one in Washington.

The Geophysical Laboratory of the Carnegie Institution of Washington, D. C., was placed in charge of optical glass production under the War Industries Board and its staff coöperated in the management of three of the plants which produced the bulk of the glass manufactured. This Institution did most valuable work in insisting upon the use of extremely pure raw materials, in the testing of the finished glass, the annealing process and other incident problems.

The Bureau of Standards contributed the development of special glass pots, made from porcelain-like bodies, rapid testing methods for the examination of the glass and an elaborate study of the changes occurring on annealing. Its Washington plant is still on a productive basis and makes optical glass for the Navy.

It might be said therefore that we have succeeded in establishing an optical glass industry in this country, which is in position to supply all of our peace and war needs.

All of the improvements made in the optical work benefitted the commercial glass manufacturers in indirect ways, and as a result they have, in many instances, made changes in processes. Special glass, which was largely imported, is now manufactured rather extensively at home.

Chemical Glassware.—Chemical glassware, which had previously been imported is now being made in the States on a scale large enough to meet our requirements. The Corning Glass Works has developed a line of Pyrex chemical ware that is superior to anything previously imported.

Chemical Porcelain.—Chemical Porcelain is now being manufactured at home and it is hoped this industry will continue to thrive. The quality of the American ware is satisfactory but the cost of manufacture is necessarily high and, like the pottery trade, dependent upon reasonable protection.

Refractory Porcelain.—Refractory porcelain, particularly pyrometer protection tubes, was not available shortly after the War began. The actual value of this product is not great, but the lack of it was keenly felt. At least four concerns are now manufacturing these products with considerable success. The original tubes were developed by the Bureau of Standards.

Spark Plugs.—The demand for high grade porcelain cores for spark plugs has been largely caused by the severe use to which they have been subjected in airplanes and in later types of engines where high temperatures and pressures are required. Here, Bleininger and his associates of the Bureau of Standards were able to produce a better porcelain which was rapidly taken up by some of the more progressive manufacturers and produced on a commercial scale. It was found that the alkalies and free quartz were objectionable and the use of substitutes necessitated the use of much higher temperatures than are commonly used. This again compelled the use of special refractories for the saggers and the kiln linings for which pure silicon carbide is largely employed.

Abrasives.—There was undoubtedly considerable improvement made in abrasives during the War but perhaps the greatest benefit was the development of uses for abrasives, particularly grinding wheels. A great deal of machine shop work is now being done with grinding wheels that was previously done in other ways at a higher cost or less efficiently.

Development of Better Refractories.—Improvements were made more or less indirectly but nevertheless the results will always be felt. The demand for increased production and greater service particularly in power plants brought about a demand for higher grade refractories or improvement in design requiring special shapes and this has helped to educate the consumer to the necessity for high grade work. The experiences of the Carnegie Steel Company and other large steel companies brought about changes that have helped to make improvements.

Enameled Iron.—Here again, although there have been great improvements in quality of product, the greatest benefit has resulted from the education of the consumer and the development of new uses for the product.

Chemical Stoneware.—This industry was well-developed before the War but it should be mentioned here on account of the extreme importance of the product for the manufacture of chemicals, powder and other materials so necessary in War times. It is unfortunate that the demand for products of this character are not as great in times of peace.

Graphite Crucibles.—The inability to secure sufficient Ceylon graphite caused distress among the crucible manufacturers and still more serious was the lack of bond clay, formerly imported from Germany, which was missing entirely. The properties of the German clays and their corresponding types of American bond clays were studied by the Bureau of Standards but the whole question of graphite and clay was taken up by the Bureau of Mines which did valuable and extensive work in this connection. Through careful laboratory and shop tests it proved that graphite crucibles can be successfully made from American materials. The contribution of the Bureau of Mines on graphite crucibles represents the most complete work ever done on this subject.

The Bureau of Mines also did much work in searching for domestic raw materials to replace those previously imported. Among other activities it undertook an elaborate survey of the white clay resources east of the Mississippi.

Ceramic Schools

The Ceramic Department at Ohio State University was organized over twenty-five years ago with Prof. Edward Orton, Jr., as director. Rutgers College, at its last commencement and at the dedication of its new ceramic building, honored him with a Doctor's degree. Doctor Orton has probably done more than any other man to further the interests of ceramics, in America and indirectly throughout the world.

Prof. Charles F. Binns has also been very active for many years and he will be prominently mentioned in the history of the ceramic art in America particularly in connection with the development of the technical and artistic aspects of the industry.

The following is a brief outline of the history of ceramic schools:

TABLE I

Name of school	Ceramic department founded	Founded through efforts of	Original department head	Present department head
Ohio State University	1894	Prof. Edward Orton, Jr. and Ohio Clay Operators	Prof. Edward Orton, Jr.	Prof. A. S. Watts
New York State School of Clay Working and Ceramics	1900	Pres. B. C. Davis Hon. John J. Merrill	Prof. Charles F. Binns	Prof. Charles F. Binns
Rutgers College and the State University of New Jersey	1902	New Jersey Clay Workers	Prof. Cullen W. Parmelee	Prof. George H. Brown
University of Illinois	1905	Prof. Charles W. Rolfe	Prof. Ross C. Purdy	Prof. Cullen W. Parmelee
Iowa State College of Agriculture and Mechanical Arts.	1906	Clay and Cement Manufacturers and Users of Iowa	Prof. Ira A. Williams	Prof. Paul E. Cox
University of Washington	1918	Dean Roberts	Prof. Ira A. Williams	Prof. Hewitt Wilson
University of Saskatchewan, Canada	1921	Prof. T. Thorwaldson	Prof. W. G. Worcester	Prof. W. G. Worcester

Other Professors and Instructors not listed above: Ohio State University: Professors R. C. Purdy, A. V. Bleininger, H. F. Staley, C. B. Harrop, Hewitt Wilson; Assistants or Instructors: F. H. Riddle, J. M. Knote, W. G. Worcester, Jas. T. Robson.

New York State School of Clay Working and Ceramics: Miss L. W. Tourtellotte, E. S. Babcock, Miss Adelaide M. Blanchard, Herbert K. Cummings, Miss M. Elsie

Binns, G. K. Daghlian, A. R. Heubach, E. T. Montgomery, George A. Bole, Joseph B. Shaw, Miss Katherine Nelson, Miss Marion L. Fosdick.

Rutgers College: See Table.

University of Illinois: Professors R. C. Purdy, A. V. Bleininger, R. T. Stull, R. K. Hursh, E. W. Washburn.

Iowa State College of Agriculture and Mechanic Arts: Professors Amos Potts, Homer F. Staley, S. L. Galpin, O. J. Whittemore.

University of Washington, Seattle, Washington: See Table.

University of Saskatchewan, Saskatoon, Sas., Canada: See Table.

Relations between Ceramic Interests

By ceramic interests is meant those who are not only directly interested in the production of ceramic products but also those who are directly or indirectly connected for some other reason. Among these would be included the Trade Associations, Government Bureaus, Research Laboratories, Technical Societies and indirectly the ceramic schools.

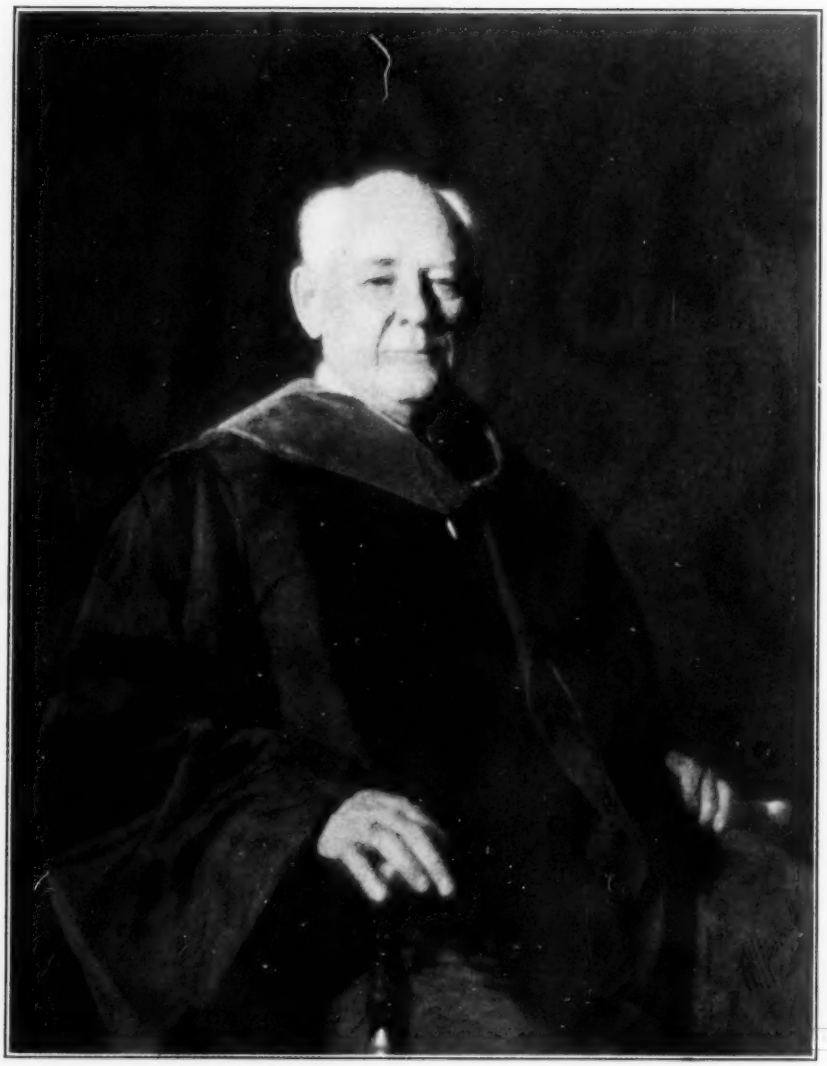
The necessities which arose during the War induced a coöperation between these interests that has made each one realize how little he can accomplish without the coöperation of the others and how much can be accomplished by this coöperation. Associations are maintained by the Potters, Electrical Porcelain Manufacturers, Tile Manufacturers, Sewer Pipe Manufacturers, Common Brick Manufacturers, Face Brick Manufacturers, Fire Brick or Refractories Manufacturers, Paving Brick Manufacturers, Several Glass Manufacturers' Associations, Enameled Iron Manufacturers, Grinding Wheel Manufacturers. Government Bureaus which are directly interested in ceramics are the Bureau of Standards, the Bureau of Mines and the United States Geological Survey. Both Bureaus have extensive equipment and specially trained technical staffs interested directly in ceramics. The Bureau of Mines deals directly with the raw materials, source, etc., while the Bureau of Standards is more interested in the product, method of testing, and development of standards.

Several of the Trade Associations have arrangements with research laboratories and have investigators working in these laboratories under the direction of joint committees made up of members on the staffs of the associations and laboratories. This is also being done by some of the manufacturers, particularly where they do not have proper facilities for carrying the work on themselves or else when they desire the work to be carried on under the direction of some specialists who are connected with some available laboratory.

All of the above associations, with the possible exception of two or three, are carrying on research work in the above way. The Refractories Association has undertaken rather extensive work which is being carried on at the Mellon Institute of Industrial Research in Pittsburgh, Pa. This Institute has directed research for several ceramic manufacturers and is to

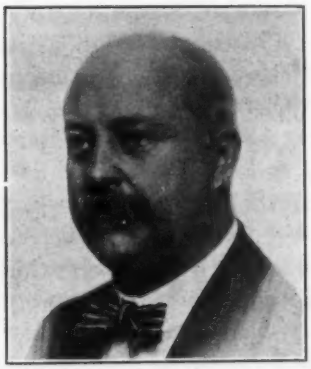
be complimented for the value of these investigations. The various brick manufacturers have appropriated a large sum of money and they, together with the Bureau of Standards, Bureau of Mines, a couple of the Ceramic Schools and representatives of the AMERICAN CERAMIC SOCIETY and National Research Council, have undertaken some extensive work. An important part of this work is that of efficiency in burning. The Bureau of Mines has equipped a car similar in character to those they use in mine rescue work and sends it right to the factory where investigation work is to be carried on so that the crew of technically trained ceramic men can be on duty at all times and also have all the apparatus necessary to carry on the work properly.

Industrial research being recognized as an absolute necessity, large corporations are appropriating hundreds of thousands of dollars annually in support of their extensively organized private laboratories. It would seem that the importance of industrial research laboratories was so evident that no manufacturer would be without one. The possibilities of economics in process, and sure improvements in products in the application of scientific discoveries and by the application of process control methods are very great; in fact it is essential that work of this character be undertaken by those who are to continue with any degree of success.



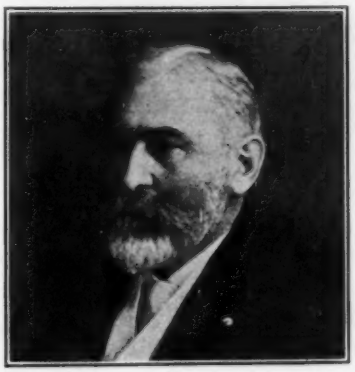
COLONEL EDWARD ORTON, JR.

OUR UNIVERSITIES



THEO. A. RANDALL

Theodore A. Randall of Indianapolis, Ind., has been secretary of the National Brick Manufacturers' Association, since its organization in 1886. He has served continuously, which is a world record.



CHARLES A. BLOOMFIELD

Charles A. Bloomfield was president of the National Brick Manufacturers' Association, 1912–13. He was first president of the New Jersey Clay Workers' Association and Eastern Section of the AMERICAN CERAMIC SOCIETY, and took the lead in organizing and managing the movement that resulted in the establishment of the Ceramic Department at Rutgers College.

D. V. PURINGTON

D. V. Purington was president of the National Brick Manufacturers' Association.

To Professor Edward Orton, Jr., E.M., D.Sc., belongs the credit for establishing the first collegiate department in Ceramic Engineering. He obtained the solid support of the members of the National Brick Manufacturers' Association, and was fortunate in having the active personal support of D. V. Purington, W. D. Richardson, W. D. Gates, Charles A. Bloomfield, and T. A. Randall, representing national interests and several of the potters and brick manufacturers of Ohio. With the support of these men, Prof. Orton overcame the opposition of the University authorities and obtained the passage of the necessary bill through the Ohio legislature.

Thus was started in 1895 the world's first collegiate course in Ceramics. Quickly following was the founding of the AMERICAN CERAMIC SOCIETY and the establishment of collegiate ceramic departments in other universities.

On the occasion of the dedication of

the new and well appointed ceramic building at Rutgers College last June, the honorary degree of Doctor of Science was bestowed upon Professor Orton in recognition of the services he had rendered to ceramic crafts of the world, in addition to similar constructive organization service in other fields, notably geology, and as Dean of the College of Engineering. His country had already decorated him with a Distinguished Service Medal and had promoted him to the rank of Colonel for the self-same organizaation success and personal inspiration to his fellows by which he had so singularly distinguished himself in ceramics and as Dean of a college.

To the pupils who have had direct contact with Professor Orton in lecture room and laboratory at the Ohio State University has been given the larger share of his inspired leadership. In recognition of this, they have presented to the Ceramic Department at Rutgers College a full-size portrait of him in his doctorate robes and colors from Rutgers.

Recognizing that the several ceramic schools from the earliest period have been largely responsible for the technically trained ceramists and for the fund of ceramic knowledge on which the present day productive scheme of coöperation and coördination in ceramic research is built, brief summary accounts of the collegiate departments are here given.

DEPARTMENT OF CERAMIC ENGINEERING, THE OHIO STATE UNIVERSITY

By Arthur S. Watts

The Ceramic Engineering Department of The Ohio State University was established by act of the Ohio State Legislature on April 20, 1894.

The Department was conceived by Eward Orton, Jr., E.M., and established largely through his efforts and with the support of a few of the clayworkers of Ohio. It was the first school of its kind in the United States, and, to the best of our knowledge, in the world. The Department opened in September, 1895, with fifteen students in a two-year course, known as "Clayworking and Ceramics" for which no degree was granted. In 1896 two students enrolled in a regular four-year course, the first graduate being Walter M. Fickes "1900," who received the degree of "E.M. in Cer." The degree conferred was changed in 1908 to "Cer.E.," and again in 1915 to "B.Cer.E."

The Department was located originally in Orton Hall with the Department of Geology, being transferred in 1906 to Lord Hall, which was erected to accommodate the Department of Mines, Metallurgy and Ceramics.

The original four-year course consisted of approximately fifty per cent fundamentals, 25% advanced general engineering and 25% fundamental and advanced ceramics. Individual courses in the curriculum have been changed but always in kind and the course at present consists of forty-

five per cent fundamentals, including culturals, twenty-five per cent advanced engineering and thirty per cent ceramic engineering.

The most important additions to the curriculum within the Ceramic Engineering Department were the application of Physical Chemistry to Ceramics, introduced in 1910, the courses in Ceramic Machinery and Factory Design, introduced in 1911, the course in Refractories and Furnaces, introduced in 1918, and special post graduate courses in Ceramics, introduced in 1917. The most notable additions to the curriculum from outside the Department are the courses in fundamental Physical Chemistry, in Fuels, in Mineralogy and in Pyrometer Construction and Operation.

The object of the curriculum is strictly professional. It does not give nor pretend to give manual skill in any of the practical arts of modeling,

Lord Hall, Ohio State University.

forming or decorating. It is a study of the technology—the engineering, which is used in the clay and allied silicate industries.

The development of ceramics has made it impossible to cover the field in more than a general manner in the time available in a four year course.

The distribution of ceramic graduates in the different branches of the industry is as follows:

Of 166 graduates, 32% are employed in crude ceramics, 14% in architectural ceramics, 20% in fine ceramics, 12½% in refractories, 8% in cement, glass and metal enamels, 8% in teaching or government research, and 5½% are not following ceramics.

The enrollment of students in the Department has never been large, the total of sophomores, juniors and seniors never having exceeded 55, and the largest class graduated being 18 in 1909. The present enrollment

is 49, with 12 seniors. Freshmen cannot be counted since they take no work in the Department.

The personnel of the Department has been as follows:

Professor Edward Orton, Jr., Head of Department, 1895 to 1914, incl.

Professor Arthur S. Watts, Professor 1913–15, Head of Department, 1915 to date.

W. L. Evans, Assistant in Ceramics, 1895 and 1896.

Theodore Griffin, Assistant in Ceramics, 1897.

A. V. Bleininger, Laboratory Assistant in Ceramics, 1898 and 1899; Assistant in Ceramics, 1901, '02, '03, and '04; Assistant Professor, 1905; Associate Professor, 1906.

S. V. Peppel, Assistant in Ceramics, 1901.

R. C. Purdy, Assistant in Ceramics, 1903, '04, and '05; Assistant Professor, 1907; Associate Professor, 1908, '09, and '10; Professor, 1911; Acting Head of Department, 1909.

F. H. Riddle, Laboratory Assistant, 1906.

W. G. Worcester, Laboratory Assistant, 1907, '08, and '09; Instructor, 1910.

J. H. Knote, Laboratory Assistant, 1907.

H. F. Staley, Associate Professor, 1910; Professor, 1911.

C. B. Harrop, Assistant Professor, 1911 to date.

A. P. Potts, Assistant in Ceramic Engineering, 1911.

F. K. Pence, Professor, 1912.

J. C. Lysatt, Mechanician, 1912 to date.

Hewitt Wilson, Assistant Professor, 1917 and '18.

J. T. Robson, Instructor, 1919 to date.

NEW YORK STATE SCHOOL OF CLAY-WORKING AND CERAMICS

By Charles F. Binns

The School of Clay-Working and Ceramics at Alfred, N. Y., was founded by an act of the Legislature of the State of New York in 1900. This act appropriated $15,000 for the building and equipment and $5,000 for the expenses of the first year. Incredible as it may seem, a good sized building was erected for $11,800 and although it was built of brick it was a mere shell. The partitions and stairways were all of wood. It had no heating system or plumbing. Gas stoves were borrowed from the University and by dint of strict economy the equipment was assembled. Appropriations were not then itemized, a fact which rendered this possible.

At that time the chief thought which ruled ceramic education was brick. The solons at Albany had to be told that the raw materials of the

State should be more fully utilized, that better building material should be produced, and that, therefore, the school should be established. It was forgotten, or perhaps had not then been announced, that the chief raw material lies in terms of human beings and that the proper product of all education is men and women.

In pursuance of the brick idea the basement of the school was equipped as a brick plant. Drypan, pug mill and augur machine were purchased, the pug mill being elevated in proper style upon a huge platform up to which the perspiring students were expected to shovel the clay. Probably a mechanical elevator would have been put in if there had been money enough. The pug mill with its platform has long since disappeared and a wet pan has been added. The power was and is furnished by a 36-H. P. Otto gas engine.

New York State School of Clay-Working and Ceramics.

Not to neglect the study of pottery, a slipmaking plant, a potter's wheel and a jigger with pull-down were installed, together with mold making and sagger making appliances and tools.

A chimney stack about 60 feet high was built and at the base of this a kiln, patterned after the kiln at Ohio State. A wooden shed protected the kiln but was not connected with the building so that everything to be fired had to be carried across the open. In 1915 a considerable addition was made to the building consisting of a fireproof wing to house the kilns and furnaces, with a chemical laboratory and a large general workshop.

From the beginning the director planned to include some instruction in art in the curriculum although, for the reason already stated, this was not emphasized. Nevertheless, Miss Alice Upton, a graduate of Pratt Institute, Brooklyn, was engaged as instructor in drawing and modeling and for some years she, and her successors, with the director, constituted the entire teaching staff. Ten years elapsed before it became possible, as it had long been desirable, to divide the art work, appointing an associate professor of modeling and another of drawing and design. Not until 1912 were the funds made sufficient to provide an assistant in technology, the director up to that time having taught this subject single-

New York State School of Ceramics.

handed. At the present time the following persons are on the faculty:

Charles F. Binns, Director
J. B. Shaw, Professor of Ceramic Engineering
Marion L. Fosdick, Professor of Modeling
Arthur H. Radasch, Professor of Chemistry
Erna Sonne, Associate Professor of Design
George Blumenthal, Jr., Instructor.

There are several student assistants, and in addition the faculty of Alfred University gives instruction in all general collegiate subjects.

The registration of students progressed uniformly, if slowly. Beginning with three or four it mounted steadily to about forty and for several years

remained almost stationary but at the close of the War there was a great increase until in 1922 there were more than a hundred.

This school standing alone in the attention given to art training as applied to ceramics has been applied to for teachers by practically all the institutions where the designing and making of pottery is taught. Most of those who take this course are young women although a few men have graduated in applied art with conspicuous success.

The majority of the men prefer the course in ceramic engineering and these constitute about seventy per cent of the student body. There has been no difficulty as yet in the graduates finding attractive positions and a number of them have attained some importance in their profession.

ALFRED, N. Y.

THE CERAMIC DEPARTMENT AT RUTGERS COLLEGE AND THE STATE UNIVERSITY OF NEW JERSEY

BY GEORGE H. BROWN

Rutgers College, founded in 1766, first gave service to the ceramic industries of New Jersey through a vice-president of the College, the late Dr. George H. Cook. His report on the New Jersey clays,[1] which he investigated as State Geologist, together with Dr. J. C. Smock, also of Rutgers, is only one example of his achievements in this field of work. Situated in the center of the Raritan River clay-working district and in close proximity to the ceramic industrial centers of Perth Amboy and Trenton, Rutgers College was the logical place for the establishment of a Ceramic Department.

In the year 1901, a group of men representing some of the ceramic plants in the State, under the leadership of Mr. Charles A. Bloomfield, made an effort to secure legislation toward the establishment of a Ceramics Department at Rutgers College. The first bill was defeated but its sponsors were not discouraged and when the bill was again introduced in the Legislature in 1902, it passed with but one dissenting vote (Laws, Session of 1902, Chapter 17). The initial appropriation for building and equipment was $12,000, with an additional $2,500 for maintenance during the year 1903.

Having available the appropriation, the next problem was to secure a suitable building for the housing of the new Ceramics Department. The College buildings were either taxed to capacity or else unsuited for the purpose in view. It was finally decided to use a two-story brick stable which was the property of the College. The stable had six small rooms with a total floor space of about 1600 square feet. This served as

[1] Report on Clay Deposits of Woodbridge, South Amboy and other places in New Jersey. 1878.

a nucleus and a one story brick addition was built on to complete the first Ceramics Building at Rutgers College.

The machinery room, store room, drying and kiln rooms were located on the first floor. On the second floor there was a class room, combined library and museum, together with the director's office and laboratory. The ceilings in all these rooms were very old fashioned and low and it was found necessary to light and ventilate the laboratory by means of a glass skylight. The rooms were renovated, cases were built in for displaying specimens, etc., and all available space was utilized to the best possible advantage. The usual line of clay-working machinery was installed, together with one coal-fired kiln.

Two courses of study were arranged—the regular course, covering a period of four years, and a short course of two years.

Neilson Campus elevation, Ceramics Building, Rutgers.

The new Ceramics Department was organized under the direction of Dr. W. S. Myers, at that time head of the Chemistry Department at Rutgers College. Professor Cullen W. Parmelee took charge of the Department in 1903 and continued at its head until he left to serve as Professor of Ceramic Engineering at the University of Illinois in 1916. To Professor Parmelee is due great credit for the difficult organization work necessary to the establishment of the new Ceramics Department.

Professor Parmelee was succeeded by Professor George H. Brown, who came from the Bureau of Standards, Pittsburgh, Pa., to accept the directorship of the Department. Messrs. H. W. Moore (Precision Grinding Wheel Co., Philadelphia, Pa.); G. A. Williams (Atlantic Terra Cotta Co., Perth Amboy, N. J.); C. F. Geiger (Carborundum Co., Perth Amboy, N. J.); F. S. Thompson (Freehold, N. J.) and E. C. Hill (Conkling-Armstrong Terra Cotta Co., Philadelphia, Pa.), served on the teaching and research staffs at some time during this period.

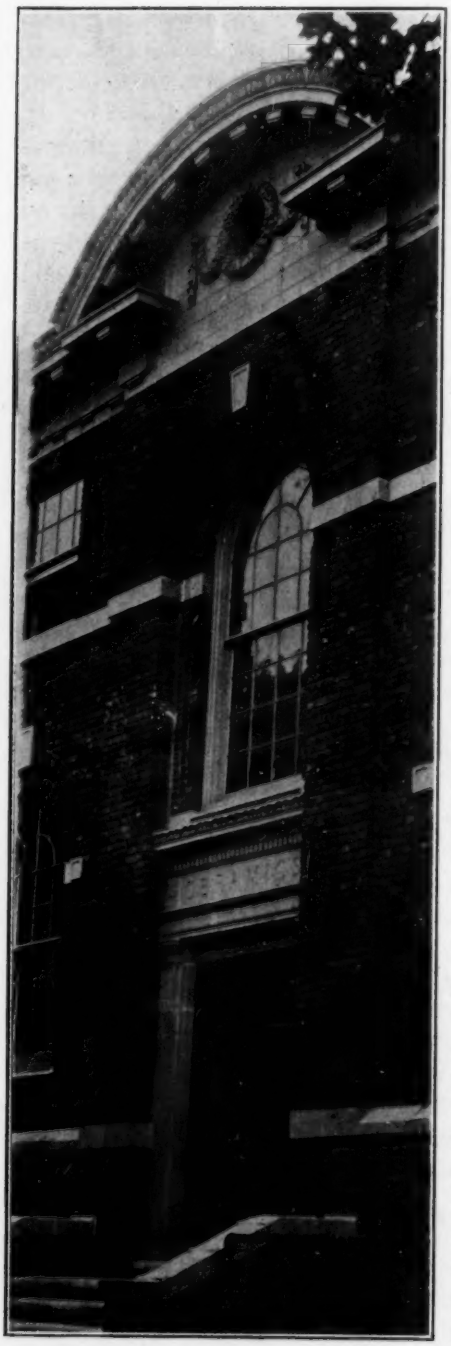
After eighteen years of service to the industry, the Ceramics Depart-

ment completely outgrew its old quarters. Realizing this fact, the New Jersey Clay Workers' Association in 1919 launched a campaign for a new building which would be more in keeping with the importance of the industry in the State. State Senator Thomas Brown of Middlesex County, sponsored the project and gave it his whole-hearted support. Representatives of practically every ceramic concern in the State lent their aid to the measure through personal letters to their legislators, etc. After an interesting series of hearings before committees of the legislature and the Governor, Senate Bill No. 17, appropriating $100,000 for the erection and equipment of a new Ceramics Building at Rutgers College and the State University of New Jersey, became a law, and the necessary sum was included as an item in the annual appropriation bill.

Terra cotta entrance, Assembly Room, Ceramics Building, Rutgers.

An excellent site on Neilson Campus was assigned for the building. A prize competition was held under the direction of the Eastern Terra Cotta Manufacturers' Association for the purpose of securing a suitable design for the proposed building. Many helpful suggestions were included in the prize winning drawings, which were submitted to the architect for his consideration in drawing up the final plans. The building is of Colonial design, the architecture conforming with that of the other buildings on the Campus. Under the direction of the State Division of Architecture and Construction, contracts were awarded for the erection of the new building. Ground was broken during the summer of 1921 and the completed building was dedicated on Commencement Day, June 13th, 1922.

The new building is located on Neilson Campus, adjacent to the Engineering and Chemistry buildings. It is a far cry from the stable of 1903 to the modern and commodious structure, 45 x 102 ft., consisting of two floors and basement, with a total of 29 rooms. The building is constructed almost entirely of burned clay products and is representative of every line of ceramic manufacture in New Jersey. The handsome terra cotta exterior finish, tiled floors and corridors, sanitary wares—to mention only a few—are splendid examples of the high excellency of ceramic products manufactured in New Jersey. The building is a combination of the artistic and the practical.



George Street entrance and façade, Ceramics Building, Rutgers

The building is completely equipped for instruction and research work in ceramics. Modern machinery and equipment have been installed, including a number of new test kilns and furnaces. A chemical laboratory has been provided, filling a long-felt want in the Department.

The Department of Ceramics is under the direction of Professor George H. Brown (Cer.Eng., O. S. U. '08); Clifford C. Clarke (B.S., Colgate, M.Sc., Rutgers) and Harold T. Coss (B.S., Illinois) are serving as assistants.

The enrollment in the Ceramics Department is 25—a threefold increase over its largest enrollment heretofore. The young men of the State are becoming more and more interested in ceramics and there is every indication of a material increase in enrollment in the near future. The men enrolled in the course at the present time are bright and energetic students who are taking a real interest in ceramics.

The part played by the New Jersey Clay Workers' Association and Eastern Section of the AMERICAN CERAMIC SOCIETY in the culmination of this worthy project cannot be emphasized too strongly. From the start the Ceramics Department at Rutgers has had their whole-hearted support, both spiritually and financially. Their generosity in supplying large quantities of ceramic products and liberal sums of money has alone made possible the handsome structure which the Department now oc-

cupies. Approximately $25,000 in cash and materials was added to the original appropriation by the members of this Association to enlarge, improve and equip the building. With the completion of the new building, the interest of the Association in the Department continues, and they are ever solicitous of its welfare and advancement.

The Annual or Winter meetings of the New Jersey Clay Workers' Association and Eastern Section of the AMERICAN CERAMIC SOCIETY are held at Rutgers College during the month of December. Owing to lack of accommodations, it has been the practice to hold these meetings in one of the other College buildings and it is a source of gratification to the Department that the Association can be fittingly entertained in its own quarters at future meetings.

The student organization, the Rutgers Ceramic Club, an offspring of the Ceramic Department at Rutgers College, holds monthly meetings during the College year. Lectures are given at each meeting covering some phase of the ceramic industry. An invitation to attend the meetings is extended to officers and employees of the ceramic plants in this district. The technical papers and ensuing discussions are proving very interesting to the students and a large attendance is always on hand.

The activities of the Ceramics Department have been considerably broadened by the act providing the appropriation for the new building. The Department has been officially designated as the "New Jersey Ceramic Research Station." Its functions are as follows:—

1. To provide a four-year curriculum in ceramic engineering.
2. To provide short courses in ceramics for practical clay workers.
3. To provide extension courses in ceramics in the ceramic centers of New Jersey.
4. To advise and assist the manufacturers of ceramic wares in the solution of technical problems arising in the industry.
5. To undertake researches for manufacturers under a system of contracts.
6. To conduct researches on problems of general interest to the ceramic industries and to publish the results of these investigations.

Located in the center of one of the greatest clay producing States in the Union and with the full coöperation and support of manufacturers of ceramic products in New Jersey, the Ceramics Department at Rutgers College has indeed an unusual opportunity for service in the advancement of the ceramic technology of her industries.

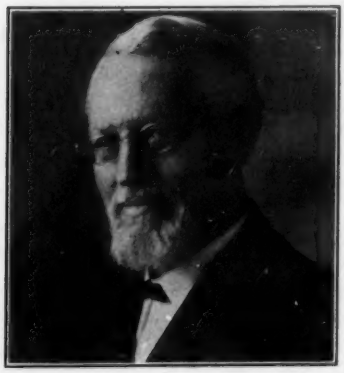
NEW BRUNSWICK, N. J.

HISTORY OF CERAMIC EDUCATION AT THE UNIVERSITY OF ILLINOIS

BY CULLEN W. PARMELEE

Ceramic education at the University of Illinois owes its origin to a plan originated and formulated in 1894 by Professor Chas. W. Rolfe who

was at that time Professor of Geology. He conceived the idea of the establishment of a "Laboratory of Economic Geology" at the University and prepared a little printed circular, a copy of which is before me, which discusses the necessity for state aid in the investigations of mineral resources of the state. In the "Bill for an Act to Establish a Laboratory of Economic Geology" which he prepared, it is specified that the director of the proposed laboratory shall collect samples of coal, clays, building stones, materials for the manufacture of glass, limes and cement, subject these samples to such analysis and *combinations as will demonstrate their valuable properties;* publish bulletins and make a collection of raw materials and products. While the bill did not specifically mention instruction, yet it would have been an easy and logical procedure to use the staff and laboratories for the purpose. That, in fact, was the intention.



PROF. C. W. ROLFE

This bill had the cordial support of the Illinois Clay Manufacturers' Association and the coal miners. The president of the University approved the bill, but later the time seemed inopportune for this project.

Thereupon, Professor Rolfe was obliged to let the matter lie dormant until 1905 when he received the sanction of President James, who had recently been installed, to proceed with his plan. A vigorous campaign was undertaken to secure favorable action by the Legislature. Professor Rolfe had strong support from the Illinois Clay Manufacturers' Association and especially the active assistance of individual members who were untiring in their efforts. Special acknowledgment should be made for the assistance rendered by Mr. William Hammerschmidt, Mr. Frank W. Butterworth, Mr. John Stipes, Mr. W. D. Gates, and Mr. A. W. Gates, Dr. A. L. Converse, and Mr. D. V. Purington.

The Legislature responded favorably to the appeal by passing a bill in 1905 which provided for a State Geological Survey, and directed the University of Illinois to provide instruction in ceramic technology. The sum of five thousand dollars was appropriated for each of the first two years.

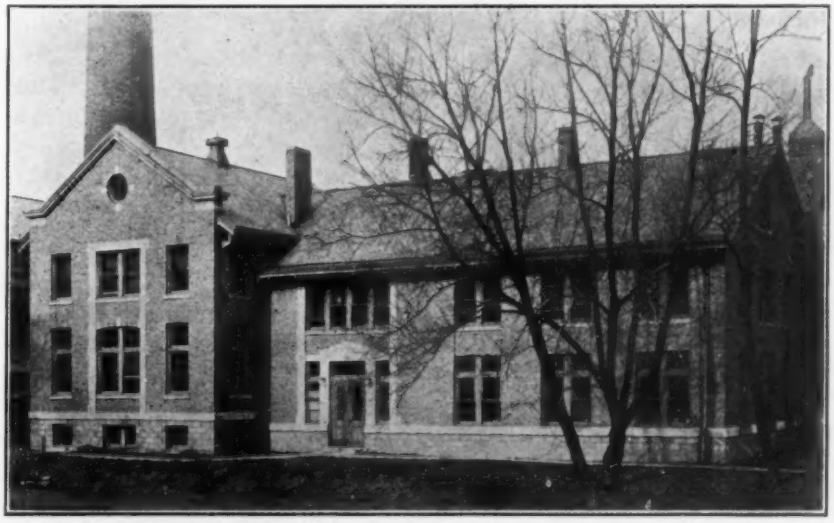
Professor Rolfe was appointed director and Mr. Ross C. Purdy was selected as the instructor.

The new department was housed in two rooms in the basement of the Natural History Building and a small kiln house was built at some distance from the laboratories. Two courses of study were instituted, one which contained a larger amount of cultural and pure science subjects, while the other had more engineering subjects.

Since that day of a modest beginning the department has steadily progressed. It early outgrew its small quarters and limited equipment. As more students enrolled the staff was increased and in rapid succession better facilities were acquired.

Owing to the limited space available for this history, it necessarily must be brief, therefore, only the most important developments can be summarized.

During the period between 1905 and 1910, Professor Rolfe was in charge, and the members of the staff were Mr. Purdy (1905–07); Mr. A. V. Bleininger (appointed assistant professor in 1907); Junius T. Krehbiel (1906–07); Ray T. Stull (appointed instructor in 1907); John McB. Knote (instructor 1908–11). The attendance increased from the initial five students to a

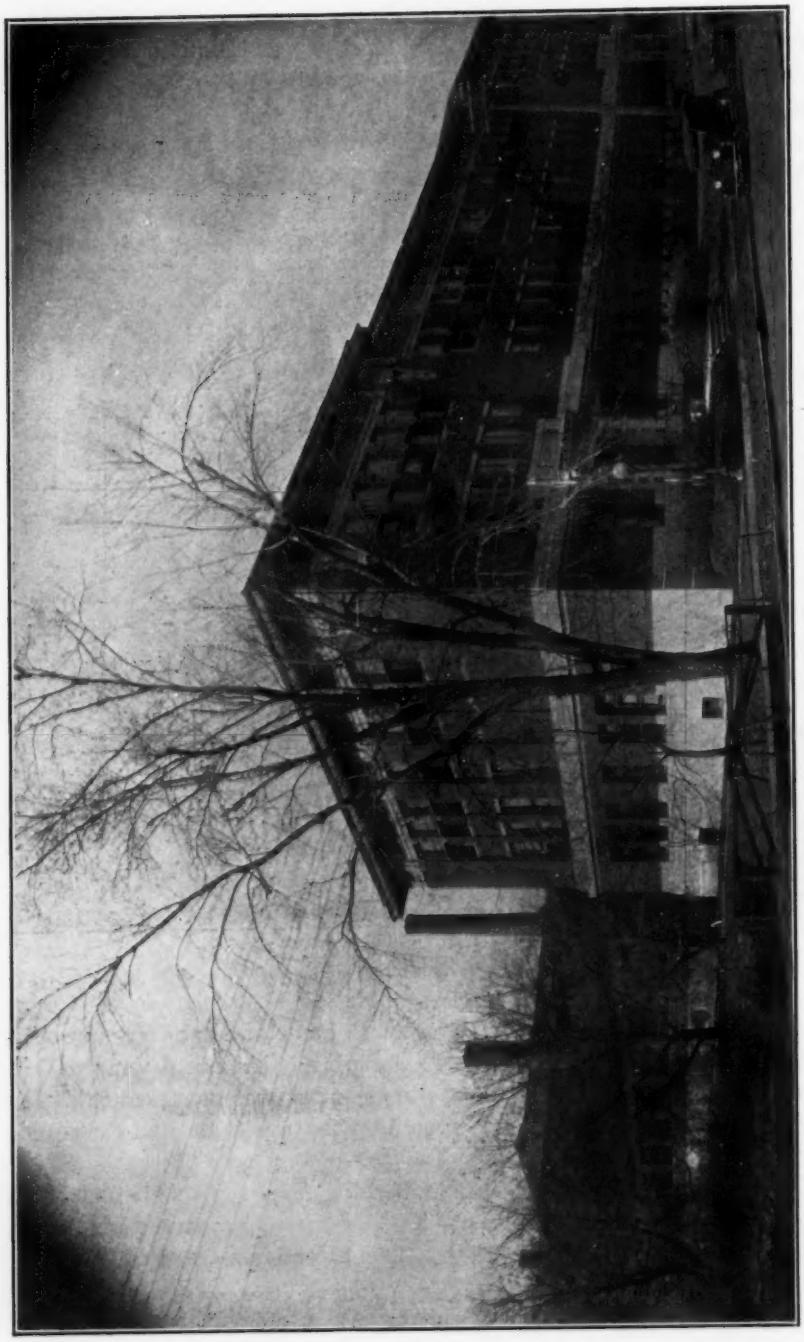


Ceramics Building (old).

maximum of twenty-one. An attempt was made to secure an appropriation from the Legislature for a suitable building. The first attempt failed, yet the annual appropriation for the department was increased to fifteen thousand dollars. In 1910 a two-story building was built, and the equipment was greatly improved.

In the period between 1910–1912, Albert V. Bleininger was Director and Professor of Ceramics, and Ralph K. Hursh was appointed instructor, 1911, and associate professor, 1921. The attendance reached a maximum of forty-five.

Mr. Bleininger left the department in 1912 to go to the newly created laboratory of Clay Products of the U. S. Geological Survey. Ray T.



Ceramics Building and kiln house (rear).

Stull succeeded him with the title of Acting Director of Courses in Ceramics (1912–15). During his administration the attendance reached a maximum of eighty-four undergraduate students; the industrial, that is, "Short Course," of two weeks' duration was instituted in 1913.[1] A kiln house was built and equipped with kilns, furnaces and machinery (1912) and the project of a new ceramics building was initiated which culminated in the appropriation by the Legislature of funds for the erection (1915–16) of the present three-story structure (see p. 100). New members added to the staff were Arthur E. Williams (1914–16); and Barney S. Radcliffe (1912–16). Other important changes were the transfer of the department from the College of Liberal Arts and Sciences to the Engineering College; the strengthening of the curriculum along engineering lines; and the dropping of the more general course in Ceramics.

For a few months after Mr. Stull left the department, Mr. A. V. Bleininger was in charge, while on leave of absence from the U. S. Bureau of Standards. When he returned to the Bureau, Mr. R. K. Hursh assumed charge.

In September, 1916, Dr. Edward W. Washburn was appointed as Head of the Department and Professor of Ceramic Chemistry. Dr. Washburn had been connected with the Department of Chemistry for several years and during a part of that time had been head of the Department of Physical Chemistry. At the same time (1916) Cullen W. Parmelee came as Professor of Ceramic Engineering, and Howard C. Arnold (1916–17) as assistant. The department moved into its new building and additional equipment was procured. With the entry of the United States in the War, the attendance decreased to a small number (26) in 1917–18. After that it steadily grew until in 1921–22 there were seventy-two undergraduates. Additions to and changes in the personnel of the staff were as follows: Earl E. Libman, served as assistant and later as instructor (1917–22); Frank F. Footitt, research assistant (1917–18); Jos. E. Seabright, instructor (1918); Dr. Elmer N. Bunting, research associate (1920 to date); George R. Shelton, research graduate assistant and later Corning Glass Works Fellow (1921–22); J. Johnson (1917–19); Enoch G. Bourne (1919 to date), potter and laboratory demonstrator.

Aside from the improvements in the facilities for instruction, a significant development during the period was the character of the research. This was directed almost exclusively along the lines of the study by physical-chemical methods of fundamental problems in ceramics, such as the investigations of the viscosity of molten glass and methods for determining the porosity of burned clay wares.

The curriculum was broadened by the introduction of the "Ceramics"

[1] This succeeded a briefer course which had been conducted by the Dept. under Prof. Rolfe.

Course. This resembles its predecessor of a similar name. It contains much more chemistry and less engineering than the course in Ceramic Engineering.

The school year of 1922–23 has begun with the department in charge of Cullen W. Parmelee[1] as Acting Head. Mr. Thomas N. McVay has been appointed to the staff as instructor. The attendance of undergraduates has increased to seventy-eight students.

Such having been the conditions under which the department has germinated and grown it is worth while considering the results.

During all these years, those in charge recognized the obligations of the department to the state and to the industry. If any motto should be chosen to describe the aspirations of its leaders it would be the word "service." Many are the requests which have come for information and advice, and many have profited by such assistance. The organization of the Industrial or Short Course in 1913 was inspired by the desire to serve the interests of the clay workers of the State who had enthusiastically and persistently urged the needs of the department. The success of these short courses may be judged from the numbers attending which reached seventy in 1922, and also by the wide diversity of interests and the many states represented—twenty at the latest session.

It is quite impossible to discuss in detail all of the contributions of investigation and research made by members of the staff during the department's history. We can indicate only a few of the more conspicuous achievements; for example, the important papers by Purdy and co-workers on fritted glazes, crystalline glazes and pyrochemical behavior of clays; Bleininger's study of the heat distribution in industrial kilns and the preheating of highly colloidal clays as a method for rendering them available for use; Stull's studies of porcelain glazes and slips for enamel brick; Hursh's investigations of the heat balance of ceramic kilns; Washburn's and co-workers' contributions on gases dissolved in glass, methods for determining porosities and the measurement of the viscosity of glass. Purdy, Bleininger, Stull, Hursh, Williams and Parmelee have prepared or assisted in the preparation of reports on the clay resources of this and other states.

With regard to the graduates of the school, it is well to note that the department has always insisted upon the completion of four years of undergraduate work as the minimum training for a young man preparing for effective service in the ceramic industry. A total of eighty-one men have completed such training and have received the traditional "sheepskins." They are distributed as follows:

Heavy clay products	16
Misc. whiteware	11
Refractories and abrasives	12

[1] In 1918–19, while Dr. Washburn was absent on leave, Prof. Parmelee was in charge.

Glass	6
Enameled metals	3
Terra cotta	4
Ceramic instruction	2
Misc. or not known	23
Dead	4

Seven men have received the Masters Degree in Ceramic Engineering, and two have majored in Ceramic Engineering for the doctorate.

This history will be incomplete without a brief statement regarding the courses of instruction, building and equipment. As already indicated, there are two four-year courses, Ceramics and Ceramic Engineering. In both courses the studies are prescribed, although a limited amount of freedom in the choice of non-technical and technical electives is permitted. The plan of instruction in both courses naturally provides for the necessary preliminary training in the fundamentals, *i. e.*, rhetoric, chemistry, physics, and mathematics. The general principles of ceramic technology are reviewed and an opportunity is afforded advanced students to choose electives dealing with highly specialized branches of the industry, such as cement, glass, enamels, etc.

When the department was inaugurated it was provided with two rooms in the basement of the Natural History Building. Special provision had to be made for the kilns so a small brick building, about twenty feet square was built. This also housed the dry pan. This building was informally known as Purdy Hall.

In 1909 the Illinois Clay Manufacturers' Association issued a circular which states that the department is obliged to use "a room or two in the basements of each of three buildings scattered over a distance equivalent to three city blocks." This condition was relieved by the erection of a two-story brick building with basement having a total floor space of 6036 sq. feet. This building was situated about one hundred feet from the old kiln house, Purdy Hall, which was an improved but not an ideal condition.

In 1912 a one-story brick building was built one block distant as the first unit of a new ceramics plant. This building has a total floor area of 11,200 square feet and is used in part by the mining department. It contained a kiln room of 4300 square feet and also offices and classrooms for the department.

In 1915–16 the present ceramics building was constructed. This adjoins the kiln house, just described. The building is a three-story edifice covering a ground area of 67 x 189 feet. The ceramic engineering department uses one-half of the basement for storage and plaster shop, one-half of the first floor for offices, storeroom, laboratories and clay shop; the second floor is used entirely by the department for research laboratories, offices, museum, recitation room, lecture rooms, and reading room.

The equipment of the department includes very complete installations for the manufacture of brick of various kinds, drain tile and hollow ware, pottery and floor tile, saggers, and special refractories, enamels, glass and cements.

The furnace equipment includes a Morgan gas producer, three laboratory coal burning and two oil burning kilns of considerable size, a decorating kiln, an enameling furnace, a small furnace with preheated air and gas supply, a battery of five frit furnaces with preheated air and gas supply, and miscellaneous small furnaces for fusion tests, etc.

The student organizations which have been identified with the department began with the Ceramics Club which dates back to 1907. This was succeeded in 1916 by the University of Illinois Student Section of the AMERICAN CERAMIC SOCIETY. In 1915, Keramos, a fraternity was organized by a small group of students who have conducted its affairs according to the usual practise for secret societies.

Research has been fostered by the relation of the department to the Engineering Experiment Station. A Research Associate in Ceramic Engineering is a member of the Department staff and several Research Graduate Assistants have been appointed to the station staff to conduct their investigations under the direction of members of this department.

URBANA, ILLINOIS

DEPARTMENT OF CERAMIC ENGINEERING OF IOWA STATE COLLEGE

BY PAUL E. COX

The first mention made of instruction in ceramic engineering at Iowa State is found in the catalog of 1899–1900, under Samuel Walker Beyer, Professor I. A. Williams instructor. No students enrolled for the course, which was a two-year course only. The work was to be taught without very much in the way of equipment, and it is interesting to note that ceramic engineering was tied to mining engineering, which was in turn a part of the geology department.

There were no changes until 1906–1907 at which time a course in Ceramic Engineering was authorized by the legislature and this new department together with the Department of Mining Engineering moved from Morrill Hall into the new Engineering Hall. Two courses in Ceramics were offered, the one being the two-year course and a four-year course, which really was a five-year course because it called for a year in residence of what is termed an "Academic Year." This Academic Year was nothing more nor less than a year to make up entrance requirements.

The Department of Ceramics, or rather Course in Ceramics, was established by a mandatory act of the state Legislature in obedience to resolu-

tions passed by the several ceramic goods manufacturers' associations of the State. These actions began in 1899 in the shape of a resolution toward this end by the Iowa Brick and Tile Association, renewed each year until action was taken by the legislature. In 1906 the Iowa Cement Users' Association joined with the preceding organization in a resolution favoring the establishment of a School of Ceramics, and finally a bill was prepared, presented to the legislature and enacted into a law providing for the work in ceramics at Iowa State College and, in two sections, states what is to be done in the department of ceramics. In brief the Department was expected to furnish instruction in the various branches of ceramic practice and to carry on work in the Engineering Experiment Station in research work of value to the industries listed as ceramic industries.

Anson Marston was Dean of the Division of Engineering, Winifred F. Coover, now head of the Department of Chemistry of the entire college, was Assistant Professor of Chemistry, Professor Beyer and I. A. Williams had in immediate charge the ceramic courses.

PAUL E. COX

The course of study was similar to that laid down by Professor Orton. No students appeared.

It should be understood that the research work of the faculty had been going on for some years however, and on the one hand Professor Beyer and his staff of geologists had been getting into the matter of sources of raw materials, and Dean Marston had been working on crushing tests, on common brick and other burned clay products.

In the catalog for 1907–1908 appears the name of a student who apparently did not know of ceramics for he was not enrolled in the course though his name appears. This student was Milton F. Beecher who ultimately became the first graduate of the Department of Ceramics.

In 1910–1911 the ceramics building was built as a part of the building known as the Engineering Annex. This is the building now occupied in part by the Department. A part of this building is used by the Engineering Experiment Station in its ceramic work.

In 1912–1913 Milton F. Beecher's name appears as instructor in the department.

In 1914–1915 Iowa State College undertook to offer five-year courses and in the catalog of that year the ceramics students are urged to take a four-year course in mechanical engineering and to follow it with a fifth

year of special work in ceramics. The name of Amos. P. Potts appears as Associate Professor, and Sidney L. Galpin's name appears as Assistant Professor in geology. Potts was fresh from Ohio State University and Galpin from Cornell and the hands of Dr. Ries.

The catalog of 1915–1916 shows the course in ceramics to be headed by Professor Beyer, with Homer F. Staley as Associate Professor and S. L. Galpin as Assistant Professor. There were four students enrolled. The next year there were nine students.

In 1917–1918 Dr. Galpin left and Professor Beyer and Professor Staley handled the work alone, there being seven students enrolled. In 1918–1919 Professor Staley left for work in the Bureau of Standards, and was replaced by Dr. Galpin. During the War Dr. Galpin was in charge, with O. J. Whittemore as Assistant Professor in ceramics. Remembering the fact that the World War had shattered the organization it is not surprising to find but three students enrolled for work in ceramics. Professor Beyer had become Dean of the new division of Industrial Science and in general a new organization had to be effected, with Dr. Galpin the only mature person in charge of the work, and with an overload of teaching in both mining and ceramics.

Professor Whittemore resigned in the fall of 1921 and Paul E. Cox came into the faculty. Dr. Galpin was in charge during the year of 1921–1922 and was then relieved from direct work in the Department of Ceramics and was so enabled to give full time to his work as Associate Professor of Geology. In the fall of 1922, Prof. Cox was placed in charge of the work of the department and D. A. Moulton was added with the rank of Assistant Professor. It has always been customary to have at least one man on the staff to give half time to the work of the Experiment Station and Prof. Moulton was appointed for that work.

Since 1915 work has been given to students of the Division of Home Economics and others in modeled pottery. Miss Ethel J. Bouffleur from the University of Washington was selected to conduct these courses.

There have been from 10 to 14 students entered for the four-year course the past three years, and there have been as many as 60 students per quarter from other departments for work in modeled pottery. There has never been fewer than 20 enrolled for this popular course.

Since Iowa is state endowed with materials suitable mainly for brick and similar products the stress in the engineering work is placed on the heavy products. The course of study is about the same as that of other schools.

Since half of the work of the department is the Engineering Experiment Station work it should be pointed out that the pioneers did fine things in the Bulletins they prepared. Beecher's work on the fire clays of Iowa was negative but conclusive. Staley put out several bulletins, timely and

useful. Whittemore with Whitford, a graduate student, produced a Bulletin on glazes possible for pottery work on Iowa clays, and this Bulletin has been a popular one.

A fine new kiln has been built, with capacity for 800 pavers or the equivalent. A high temperature furnace of the sort described by Prof. Moulton at the St. Louis meeting is being constructed. A heavier motor has been added, and many pieces of machinery placed that had been bought and never used.

IOWA STATE COLLEGE
AMES, IOWA

CANADA'S FIRST CERAMIC SCHOOL: UNIVERSITY OF SASKATCHEWAN

BY W. G. WORCESTER

That a new country may grow it must have people. To first attract and later to hold and support a population there must be a development of the natural resources of that country. The development may be along agricultural lines or those dealing with the basic materials of a metallic or non-metallic nature, though better still through a simultaneous exploitation of both.

Had the western provinces of Canada taken cognizance of the above fundamental principle from the start their census figures might not have shown the remarkable per cent gains as were recorded, but a far more substantial foundation of proper balance would have been formed.

W. G WORCESTER

That the country could not exist indefinitely on the sub-dividing of perfectly good ranch lands into town lots was forcibly and undeniably impressed upon the builders of western Canada by the War, as early as 1914. During the years of that great struggle all of Canada responded, literally speaking, to the last man. The lull, however, thus created in the daily life of the Dominion gave time for the thinking minds to survey the work of the past, and, in light of the mistakes that had been made to plan for the morrow along lines of sane stability.

It was apparent that the foundation for this stability must be built upon the country's natural resources, investigations and surveys were started with that object in view; notably was the important work by Ries and Keele on the Clays and Shales of Western Canada followed by a valuable

investigation by Mr. N. B. Davis, M.A., B.Sc., on the Clays of Southern Saskatchewan[1] for the Department of Mines, Ottawa.

The work of Davis proved the existence of large deposits of valuable clays in Saskatchewan; these clays were shown to be suitable for many lines, particularly structural wares, sewer pipe, refractories and pottery of several grades.

The Provincial Government of Saskatchewan with true western spirit was awake to the great possibilities and value of the latent clay resources, to their province, championed largely by the Hon. Chas. A. Dunning,[2] provincial treasurer and minister in charge of the Bureau of Labour and Industries. Much thought and consideration was given to the question as to the best methods of assisting in the building up of a permanent ceramic industry in Saskatchewan.

That much remained to be done from a technical point of view was obvious; over the province were numerous clay plants in various stages of development, successes and failures, largely the latter. Why was this the case? Interests were asking as to the possibilities of locating in the province and as to the nature and qualities of the clays; all of these with other problems naturally led to the question of a technical ceramic man, and in the advent of the development of the ceramic resources, where could the trained minds to carry on the work be found?

The discussions led to a consultation early in January, 1921, with Dr. Thor. Thorvaldson, Ph.D., head of the department of Chemistry, University of Saskatchewan. Dr. Thorvaldson proposed that the University establish a department of Ceramic Engineering, the head of the new department to work jointly between the University and the Saskatchewan Government in the development of a course in ceramic engineering, and, to act in a consulting way to the industry of the Province as a whole.

The President and Board of Governors of the University concurred in this arrangement with the provincial government, thus making it possible for the establishment of the first ceramic school in Canada.

The task of finding a suitable man for the position was assigned to Dr. Thorvaldson, realizing that the duties of the new instructor would not only involve technical but a practical knowledge as well, and, furthermore, a knowledge of Western Canada clays, combined with that of general business methods and conditions in a new country, were essential though not entirely necessary. Thus the field of suitable or available men was somewhat narrowed.

Among the list of names suggested was that of W. G. Worcester, a product of the early ceramic days at Ohio State University. Upon leaving the University in 1899, Mr. Worcester was engaged in the constructing

[1] Published in 1918.

[2] At present, Premier of Saskatchewan.

and operating of clay plants until his return in 1908 to act as assistant to Prof. Orton and later with Prof. Purdy. In 1912 he moved to Calgary, Alberta, Canada, and has spent the past 9 years in developing and studying the clays of Western Canada. In view of the qualifications of Mr. Worcester he was tendered the position as director of the new ceramic department; the offer was accepted and the new duties were undertaken in May, 1921.

During the past two years, in addition to the field work of collecting samples, visiting and assisting each of the clay products' plants, the work of building up the department of ceramics has been under way. Equipment, for the most part, had to be imported, shipments and delivery were slow, in fact the problem was quite different from what it would have been in a well developed country.

The course selected is one of four years, following somewhat the lines of the four-year ceramic course in the Universities of Ohio and Illinois, the aim being to give the student a general training in sciences, chemistry, physics, German or French, geology and the general principles of clay working, rather than to specialize on certain ceramic lines.

The matter of a short course has been left open but will not likely be included. In view of the ultimate need of trained or skilled workmen, it is felt that a trade school more on the lines of the English or German schools would prove more helpful in the building up of the industry than would that of a short course.

The department of ceramics is housed in the engineering building where power, air and other similar facilities are available. Up to the present a single room has been used but the volume of work has so increased that plans are now under way to increase the space by the addition of two additional rooms. The original room will then be used for kilns, clay grinding and preparation, as well as plaster work.

The second room will be equipped with a full line of pottery machinery, supplies for body and glaze making, their preparation and general student work.

The third room is to act as a classroom and economic material museum with samples or specimens of ceramic products, largely of Canadian production.

The equipment consists of an oil fired muffle kiln, pot and Deville furnace and frit kiln, jaw crusher, a special built three roll crusher, screens, ball mills, potters wheel with pull down, small auger machine with cutter, repress and dry press, in fact a general line of ceramic machinery that is being added to as rapidly as space will permit.

A new kiln is now being designed in which to test the application of Saskatchewan lignite coals to ceramic work; the kiln is to be so constructed that ordinary grates with natural draft may later be altered to forced

draft, powdered fuel, and finally to the use of producer gas. A small producer is to be built for this purpose.

The list of students, in the nature of the case, is somewhat limited. At present there are two third-year men. As to the number of students in their first and second year that may later take ceramics there is no means of knowing. All engineering students, including chemical, take work that is more or less in common during their first two years, but from present indications and interest shown there will be a fairly large number elect ceramics as their subject among the engineering courses.

As an assistant in the laboratory the duties are very efficiently carried out by Mr. W. H. Phipps, a man of broad experience in the working of clays in many lines. The early training of Mr. Phipps was in Great Britain with the Leeds Fire Clay Company, and later with the Williscroft Potteries at Hanley. He came to Canada in 1912 and has been continuously connected with western ceramic work since that date. Thus his services to the department from a practical point of view, combined with his knowledge of Western Canadian clays and conditions, are exceedingly valuable.

DEPARTMENT OF CERAMIC ENGINEERING
SASKATOON, SASKATCHEWAN

CERAMIC WORK AT THE UNIVERSITY OF NORTH DAKOTA[1]

The ceramic work at the University of North Dakota had its conception in the research work of the School of Mines on the high grade clays of the state. The courses of instruction are constantly being extended and other courses added. Ceramic electives are given to students in mining and industrial engineering. The classes in pottery are successful especially in the production of high grade stoneware and earthenware. There is also considerable interest in art pottery. In addition to the instructional work a large amount of technical and practical data on undeveloped clays of North Dakota is being accumulated.

THE CERAMIC ENGINEERING DEPARTMENT OF THE UNIVERSITY OF WASHINGTON, SEATTLE

BY HEWITT WILSON

Ceramic engineering was established at the University of Washington in 1918, as a department in the College of Mines. At the same time investigations in ceramics were begun as part of the program under the cooperative agreement existing between the University of Washington and the United States Bureau of Mines, which maintains its Northwest Ex-

[1] For full description and pictures see *Jour. Amer. Ceram. Soc.*, **5**, 140–45 (1922).

periment Station on the University campus. The department shares with the coal mining, metallurgy and electrometallurgy departments of the Bureau in an annual appropriation of ten thousand dollars from the State of Washington, besides the usual maintenance provided for the College of Mines.

The director of the ceramic work holds an assistant professorship in ceramic engineering with the University of Washington and acts as consulting ceramist for the Northwest Experiment Station. A technical assistant for laboratory work is employed by the University, and an annual ceramic fellowship of $780 for graduate students is provided from the State coöperative fund. Ira A. Williams was in charge for the first year and Hewitt Wilson has directed the work since the fall of 1919.

Purposes

Coöperation with the Industries of the Pacific Northwest.—A ceramic laboratory occupying 7,350 sq. ft. total floor space has been built and equipped with the best types of ceramic machinery.

PROF. HEWITT WILSON, University of Washington, U. S. Bureau of Mines.

The building itself is a fine example of construction with ceramic products. It is the only public ceramic laboratory on the Pacific Coast and compares very favorably with the best in the eastern parts of the United States. The neighboring industries are encouraged in the use of the laboratory and the departmental library for their experimental and testing work, or they may employ members of the staff during extra hours for special problems. A large part of the general research work of the department primarily consists of coöperation with the industries of the Pacific Northwest. The structural wares, Portland cement, lime, plaster, stoneware pottery, and clay refractory industries are well established. The market is ready for local whiteware, ornamental tile and glass products. A future market for magnesia and silica brick, special refractories, diatomaceous earth insulating brick, and enameled metals is developing. It is the work of the ceramic department to locate, classify, and test the raw materials for these new industries.

Research Work, Testing the Clays of Washington.—In the years 1919 to 1922 coöperation was arranged with the Washington State Geological Survey and the U. S. Bureau of Mines to cover the examination of properties and the collecting and testing of clay samples from all parts of

the State of Washington. A report of this work has been written and is in the hands of the publishers. It shows that the State has within its boundaries almost every variety of clay. Prominent among the State products are the following: Residual kaolins from the "Inland Empire" of Eastern Washington; buff-burning, plastic, lacustrine clays from the same region; Eocene shales from western Washington; Pleistocene red-burning clays from southwestern Washington; glacial clays from the Puget Sound area; basaltic clays from southwestern and eastern Washington; refractory clays from the Sumas, Green River, Napavine and Spokane districts; terra cotta, stoneware and buff-burning pottery clays from the Green River and Spokane districts. All varieties of red-burning structural wares can be made from the shales and the glacial, Pleistocene, and basaltic clays. And if the kaolins from eastern Washington and Idaho are used in conjunction with the feldspar deposits of Avon (Idaho), Ruby (Washington), or those of British Columbia, it may be possible to produce a high-grade whiteware body from all Pacific Northwest materials.

The Pacific Northwest can become nearly independent as to ceramic materials, because, besides the above clay materials the following are found: Diatomaceous earth in Kittitas and Grant Counties of Washington, and Crook County, Oregon; magnesite deposits in Stevens County, Washington; numerous quartzite deposits in Pierce and Stevens Counties, Washington; vein quartz in Spokane and Chelan Counties, Washington, and chromite in Oregon. In addition, Alaskan gypsum is being burned for calcined gypsum at Tacoma, and three large Portland cement plants in Washington are supplying the Portland cement for the Pacific Northwest.

While the structural ware plants are already well established, the three terra cotta companies are looking for new buff-burning clays to improve their bodies and reduce the cost of hauling.

Citizens in the southwest district, particularly around Gray's Harbor and South Bend, have been asking for local materials suitable for the common structural wares. At the present time no company is operating in that district. The clays found there have been studied and quite a number were found suitable for this work.

The clay refractory industry, which was given a start in the Pacific Northwest during the War, has been aided by the testing and sorting of all the available fire clays.

The knowledge of the location of the kaolins of eastern Washington and northern Idaho, as determined by the survey made, will be of value to the whiteware manufacturers of the East.

This is one of the first State surveys of clays made in which the newly adopted standard methods of testing of the AMERICAN CERAMIC SOCIETY have been tried out. Since the survey covers a wide variety of clays,

the general conclusions drawn will be of value in other ceramic centers.

Testing the Clays of Idaho.—Coöperation was arranged with the Idaho Bureau of Mines and Geology for the testing of clay samples and the writing of a report, entitled "A Preliminary Report on the Clays of Idaho," by Frank H. Skeels and Hewitt Wilson, published as Bulletin No. 2, 1920, by the Bureau of Mines and Geology, at Moscow, Idaho. Large quantities of kaolin and buff-burning clays are found in the Inland Empire region of western Idaho.

In connection with the testing of this large number of clays, two laboratory instruments were devised. A new mercury volumeter[1] was constructed by Ernest F. Goodner, and an oxygen-acetylene fusion furnace[2] was devised by Hewitt Wilson.

The preliminary survey of the ceramic materials will be followed by separate studies of the different classes of materials. After testing a number of whiteware mixtures, using the eastern Washington and Idaho kaolins and feldspars, a report was prepared which has been sent to the AMERICAN CERAMIC SOCIETY for publication. A thesis report was prepared by Ernest F. Goodner on four of the typical fire clays of the State, including a flint fire clay, a shale-like fire clay, a residual kaolin and a soft, fine-grained and plastic bond clay.

Laboratory tests will be made on the other valuable ceramic raw materials of the State, such as the quartzites, quartz for glass sand, Tertiary shales, glacial clays, etc., and reports made from time to time.

Super-refractory Studies.—In coöperation with the electrometallurgical department of the Northwest Experiment Station, considerable research work has been done with clay and sillimanite mixtures which have been fused in the electric arc furnace by the electrometallurgists and tested by the ceramists. It has been fortunate to have at hand electric furnace equipment such as is possessed by very few ceramic laboratories, operated by skilled electrometallurgists. Melts of 200-pound lots can be made. This study will be continued with work on melted magnesia, spinels and chromite, under the general heading of "Super-refractories."

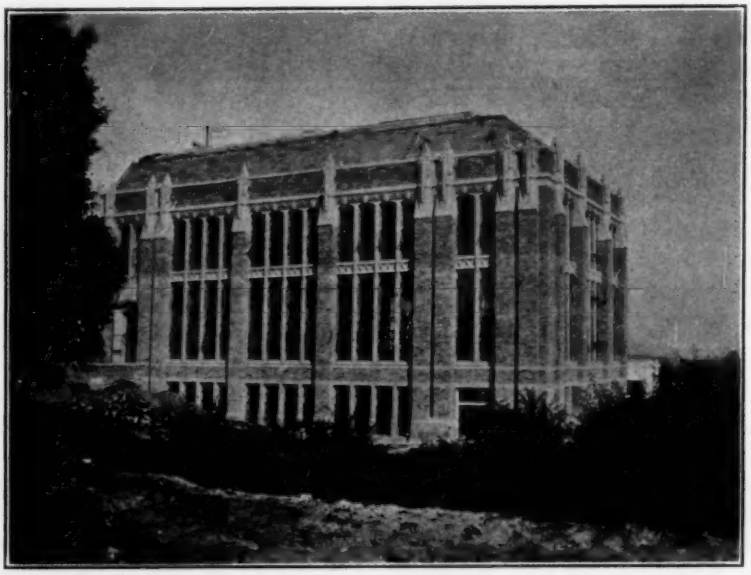
Clay Testing.—Several hundred samples of clays and other non-metallic materials have been sent in for testing from Alaska, British Columbia, Alberta, Washington, Oregon, California, Idaho, Montana, Utah, Colorado, and Central America. A preliminary firing treatment to determine the type of the clay or a microscopic examination to determine the nature of the mineral is made without charge.

[1] E. F. Goodner, "A Mercury Volumeter," *Jour. Amer. Ceram. Soc.*, **4**, 288 (1921).

[2] Hewitt Wilson, "An Oxygen-acetylene High-temperature Furnace," *ibid.*, **4**, 835 (1921).

Educational

A 4-year curriculum in ceramic engineering has been developed and tried out. It is based on the ceramic instruction given at the Ohio State University and the University of Illinois. During the development period of this complete program elective courses in cements, limes and plasters, refractories and general ceramics have proven popular with the civil, metallurgical, and chemical engineering students.



Ceramics Building, University of Washington.

Two degrees of Master of Science in Ceramic Engineering and one Bachelor of Science degree have been granted to date. These graduates are now doing creditable ceramic work with clay companies in the State of Washington. At the present time, the ceramic student body consists of one fellowship and four undergraduate students. Students in the College of Fine Arts, especially in architecture and design, make use of the ceramic equipment and laboratory space. Mrs. Eugenia Worman is in charge of the class in pottery design. The ceramic department is rapidly becoming known as the educational, technical and research center for ceramics in the Pacific Northwest.

CERAMIC ENGINEERING DEPARTMENT
UNIVERSITY OF WASHINGTON

SCHOOL OF INDUSTRIAL ART, CITY OF TRENTON

By F. F. Frederick

The work of the Department of Ceramics of the School of Industrial Art of the City of Trenton is carried on in evening classes only, as all of the men enrolled are employed in the potteries of the city and vicinity.

The course covers four years, two and three evenings per week. The first year is devoted to general chemistry, the second to qualitative analysis, the third to quantitative analysis, and the fourth to applied ceramics and ceramic engineering.

Shop Building, The School of Industrial Arts of the City of Trenton. Half of this building is devoted to clayworking. The equipment was contributed to the school by the manufacturers of Trenton and vicinity.

To secure the diploma men must produce a "masterpiece" in which either artistic quality or technical workmanship, or both, is shown; or to the development of an invention or a device that will improve some process of clay manufacture, in which the originality of the idea (not necessarily patentable) and the technical workmanship are given equal weight.

The work of the class in applied ceramics is devoted to the construction of pottery. Each man weighs his own mix, goes through the regular routine of the slip-house, casts, throws or presses a piece of pottery, and prepares it for the kiln. After the burn he prepares and

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

applies a glaze and completes his product. In special cases men with little or no knowledge of chemistry are admitted to this class.

FIG. 5.

In the class in ceramic engineering (two years of work in the Department of Chemistry required for admittance) the application of chemistry to ceramics is made, and, by means of lectures and discussions, the subject in its relation to the every-day problems of each man is considered. Twenty-five men are enrolled in these two classes.

For men interested in the art side of pottery a course in modeling is offered.

The Ceramic Department is in charge of Mr. Joseph Johnson, Ceramic Engineer with the Trenton Potteries Co., assisted by Mr. Alfred C. Grainger. The modeling is in charge of Mr. Harry Rosin. Mr. Frank F. Frederick is the Director of this School in which over thirteen hundred students are enrolled in all departments.

A corner of the kiln room, Department of Ceramics, The School of Industrial Arts of the City of Trenton.

TRENTON, N. J.

CERAMICS AT NEWCOMB COLLEGE

The School of Art, Newcomb College, New Orleans, Louisiana, includes classes in Pottery Decoration, Pottery Making, Ceramic Chemistry, Overglaze Decoration.

The classes in Pottery were started in 1896 with a group of students from the art school already prepared from the standpoint of design and drawing. Experiments were made with native clays; flowers, fruits, trees which were in profusion both winter and summer were used in decoration with a combination of blues, greens and yellows, all forming a certain character and individuality by which the standard Newcomb pottery is known.

The pottery won its first public recognition at the Paris Centennial in 1900 where it won a medal. Many other honors have been awarded it since.

The Newcomb Hand Built Pottery affords a very personal product as the pieces are built, glazed and fired by the one person. On these pieces there is little or no decoration, the appeal coming only from the form, color and texture of glaze.

OUR CERAMIC JOURNALS

The "power of the press," exemplified by the ceramic journals, has at all times been potent in its support of scientific and technical research and of plant control. They are effective media for exchange of information between the scientists, artists, engineers, equipment builders, and the manufacturers of ceramic products. They have rendered the ceramic crafts a much more valuable service as purveyors of scientific and engineering information than of current trade news items. They have at all times advocated organized coördination and coöperation in research.

The AMERICAN CERAMIC SOCIETY recognizes them as contemporaneous agencies responsible jointly with the SOCIETY for the advances which have been made during the past twenty-five years.

THE CERAMIC TRADE AND ITS OLDEST PAPER

BY STILLMAN TAYLOR

This is a brief story of forty-eight years of progress. There are few departments of industrial art which have advanced more rapidly during the past half century than has ceramic manufacture, and the history of *The Crockery and Glass Journal* parallels closely the expansion of the pottery and glass manufacturing industries in this country. As a trade journal dedicated to the trades service, "The Old and Reliable," as a good many subscribers refer to us, has from its initial number hewed close to the line and that line has been to publish the most accurate and the most useful trade paper in the field. It is chiefly due to this faithful endeavor to print all the important news which is of interest and value to the distributor of ceramic wares and to print nothing else, that *The Crockery and Glass Journal* has achieved the reputation of being the oldest and the most representative publication in its own sphere of trade.

Under the name of *The Crockery Journal* the first issue appeared Nov. 28, 1874, bearing the publishing imprint of Geo. Whittemore & Co., 103 Fulton Street, New York. This issue consisted of eight pages and the salutatory on the editorial page said, "We start without a competitor and hope to earn the approbation and hearty support of the trade by publishing a high class semi-monthly journal, treating of crockery, china, earthenware, glassware, porcelain, bronzes, decorations, etc." *The Crockery Journal* was launched in the year when oil lamps with pendant and lowering and raising fixtures were the big feature in novelties, in the period when the self-lighting gas burner was introduced and when Trenton was first referred to as the Staffordshire of America.

When the first issue of the *Journal* appeared the tariff was a topic of much controversy and singularly enough, there was also a disagreement among pottery manufacturers and workers then as now. In the January

number of the *Journal* a news article says that, "In December, 1874, the wage difficulties between manufacturers and workers at Trenton, N. J., was settled by the former declaring that no further reduction in wages would be made. The workers formed a union and among the resolutions was the following, 'That we use our moral force with the manufacturers in maintaining the present tariff unchanged, being convinced that it is to our mutual interests to do so.' About one thousand pottery workers were interested in this movement and an able man averaged $18 a week when on full time."

In comparing the present with the past, and 1922 with the year 1874, it is interesting to note from *The Crockery Journal*, that Cincinnati is referred to as a growing industrial center in the manufacture of earthenware and queensware, the annual product of that city in the year 1874 being valued at $300,000. Trenton is cited as the production center of much glass tableware but Wheeling, W. Va., was referred to as the extensive center of glass manufacturing, one of the largest firms employing 400 hands with a weekly payroll of $4,000 and operating three ten pot furnaces. Several varieties of glass were made, including white porcelain glass for lamp shades.

In a yellowed copy of the *Journal* dated Jan. 22, 1875, is a long article covering the convention of Manufacturing Potters, "held in New York City, for the purpose of organizing a National Pottery Association and to provide a fine display for the Centennial Exhibition to be held in Philadelphia in 1876." A month later *The Crockery Journal* appeared as a weekly and in a comprehensive article on the history of pottery manufacture in the United States in the April 3, 1875, issue, is the statement that "One hundred and forty-eight kilns in seven states are in operation, producing ware valued at the rate of $30,000 per kiln or a total valued production of $4,440,000 per annum."

In May, 1875, *The Crockery Journal* opened a Boston office at 178 Washington Street and a Philadelphia office at 114 South Third Street and on June 10, the editorial office was moved to 30 Vesey Street, "to be in the more immediate center of the trade." But the rapid growth of the business necessitated again moving, May 11, 1876, to larger offices at 60 Church Street near Murray, where the *Journal* was published weekly for several years. As the paper continued to grow, larger quarters were again required and the office was moved to 150 Canal Street. For some time the printing department was continued at this address but was later moved to 49 West Broadway. On April 9, 1890, *The Crockery Journal* was offered space in the newly erected Gerken Building, at 92 West Broadway, where it occupied the same office for twenty-six years. With the death of Mr. Jaques in 1920 and the retirement of Mr. Whittemore, the publishing firm of Whittemore & Jaques, Inc., was succeeded by The Demarest Pub-

lications, Inc. As *The Crockery and Glass Journal* continued to expand greatly under the new management, a larger and more modern suite of offices was secured on the seventeenth floor of the Everett Building, 45 East 17th Street, and the *Journal* moved into the uptown crockery and glassware district, May 1, 1922, where the latch-string is always out.

Forty-eight years of progress. We are proud of the achievements of the past. *The Crockery Journal* filled an important niche in the trades it represented and as the ceramic industry has so greatly expanded during the two score and eight years, so have the opportunities of *The Crockery and Glass Journal* grown to serve a larger number of readers.

Today there are six hundred and eighty pottery plants in operation, representing a capital of $133,315,940, paying $59,640,000 annually in wages and with an output valued at $108,350,220. Today, production of domestic ware is about twenty times larger than in 1874. The population of the country when the first issue of *The Crockery Journal* appeared was 38,558,371. Today it is more than 105,683,108. Because of this great increase in consuming power, and despite the great increase in domestic production, imports of china, earthenware and stoneware amounted to $10,953,783 in 1920, compared with imports valued at $6,015,945 in 1874.

The ceramic industry in this country is based on the solid foundation of a good and constantly increasing demand. It is a conservative industry, smaller and less spectacular than mining and the flowing gold of the oil fields, but it is a necessary industry and a relatively stable one and it is the ambition of *The Crockery and Glass Journal* to be of the utmost value in service to each and every one of its divisions.

"THE CLAY-WORKER," A POTENTIAL FACTOR IN THE UPBUILDING OF THE CERAMIC INDUSTRIES

By J. E. Randall

The *Clay-Worker* founded in 1884 by Theodore A. Randall, its present editor and manager, is the pioneer clay trade journal in the world, and through the thirty-nine years of its existence has, through its wide circulation, been a potent factor in the upbuilding of the ceramic industries in this country. Recognizing the need and vast possibilities in educational ceramic work the *Clay-Worker* has held steadfastly from the first an editorial policy of publishing the best articles obtainable and through its various departments, such as Kiln Department, by the Light of the Kiln Fire, Recent Patents, Foreign Scrapings, Ceramic Corner, and Brickyard Sketches, ably edited by the experienced men in the trade, has given to the clayworkers of the nation a vast fund of ceramic literature. The majority of the best books in modern ceramic literature were published first serially in the *Clay-Worker* as is mentioned subsequently.

The editor of the *Clay-Worker* saw the possibilities in organized effort in the very beginning of his work, and hence in 1886, two years after the founding of the *Clay-Worker*, with the splendid support of D. V. Purington, he organized the National Brick Manufacturers' Association, and through the *Clay-Worker* (which was made the official organ of the Association) the clay products manufacturers of this country at that time were brought together in one harmonious body of men, and much was accomplished in placing the industry on the high plane it is today.

JAMES E. RANDALL

D. V. Purington was one of the most helpful associates in the early days of the *Clay-Worker*, and it is with his aid and that of such men as W. D. Richardson and W. D. Gates, that the first Ceramic School in the country was founded at Ohio State University. The *Clay-Worker* played its part in supporting and establishing that and other ceramic schools by publishing articles by foremost men in the craft which encouraged the ceramic students and made them more eager for the higher ceramic knowledge.

In reviewing the past twenty-five years of effective work of the *Clay-Worker* the above has been mentioned to give the younger ceramists an idea of our earlier activities. Many valuable technical articles were published in the *Clay-Worker* long before 1898. We mention only two here: the series of William Waplington on "Chemistry for Clayworkers," starting May, 1892, and ending in 1897 (53 numbers), and "Hints on Brickmaking," by R. B. Morrison, starting in 1885 and ending in 1899, afterward revised and published in book form under the title of "The Brickmakers' Manual." Another book published about that time, and which is still in demand is Griffith's "Clay Glazes and Enamels."

The February, 1898, issue of the *Clay-Worker* contained in full the National Brick Manufacturers' Association convention paper of E. E. Gorton, of Terra Cotta, Ill., entitled "Experimental Work, Wise and Otherwise." The reading, discussion and publication of this paper which was editorially mentioned as an exceptionally able document planted the seed which grew and blossomed forth into the AMERICAN CERAMIC SOCIETY. Every annual and mid-summer meeting of the AMERICAN CERAMIC SOCIETY has been given a careful and exhaustive review in the columns of the *Clay-Worker* and everything possible has been done to coöperate with its officers, with the sole idea of advancing the ceramic industry in general.

To encourage the ceramic student, both in school and business life, the *Clay-Worker* has always published such technical articles as are

available, and has enlisted the aid of the best technical men in the industry. Hence, in the *Clay-Worker* of twenty-five years ago there appeared articles from the pen of such men as W. D. Richardson, Samuel Geijsbeek, E. E. Gorton, Heinrich Ries, Karl Langenbeck, H. A. Wheeler, Charles F. Binns, and A. V. Bleininger. "Artificial Pottery Bodies," by Samuel Geijsbeek; "Theory and Practice in Glaze Composition," by Charles F. Binns, and "English China Ware," by Heinrich Ries, written especially for the *Clay-Worker*, appeared in 1898. From that time on, due to the interest aroused by these articles, the *Clay-Worker* printed a great many especially prepared articles of much value to the ceramic industry, and reprinted important and valuable papers from the proceedings of the English Ceramic Society, also the AMERICAN CERAMIC SOCIETY and the German, French, British and other trade and technical journals. Of particular importance in this connection, was the paper on "Soaking and Curing Clay," by Otto Bock of Berlin, which with the discussion following same, appeared in serial form in the *Clay-Worker* during the year 1903, by special permission from the *Tonindustrie Zeitung*.

"The Use and Abuse of Clayworking Machinery," by F. E. Frey appeared in serial form during 1898 and 1899, and was very valuable to the clay industry, as were also the serials on "Artificial Dryers and Kilns," by L. C. Moore, "Fire Brick, Manufacture and Use," by Alfred Crossley and "Development of Hollow Block Manufacture," by E. G. Durant. Special articles, such as "Enameled and Glazed Brick," by S. Geijsbeek, "Clayworking in Denmark," "English China Clays," and "Clayworking in Greece," all three by Heinrich Ries, and "Utility of Art in Clay," by H. A. Wheeler, likewise appeared in 1898.

In 1900 E. E. Gorton contributed two important articles, "Defects of Glazes" and "Secret Information." Karl Langenbeck's first contribution was "The Cause of Variations in the Firing of Kilns and the Remedy for Same." Other important articles of that year were "Crowns of Kilns" and "Seger Cones," by D. W. Stookey; "Kaolins and Fire Clays of Europe," Heinrich Ries; "Chimneys and Riddle Bottom Kilns," G. S. Tiffany; "The Royal Saxon Porcelain Manufactory," Robert Grimshaw; "Exact Instruments for the Clayworker;" "Some Costly Bits of Experience," L. C. Moore; and "The Modification of the Tunnel Kiln as Constructed by Mueller and Pfeiffer."

In 1901, the more important articles were "Colorado Clay Deposits," by S. Geijsbeek; "Pulverized Coal as a Fuel for Burning," and "Light and Heat," both serials by F. E. Frey. The latter article continued through 1902 and 1903. "An Expedient for Maintaining Constant Temperature through the Process of Salt Glazing Clay Ware," I. A. Williams; "Plasticity of Clays," Edward Orton, Jr.; "Georgia's Clay Industries and Clays" (serial), "Notes on Flashing," A. V. Bleininger; "A Pacific Coast Clay-

working Plant," E. E. Gorton, and "The Birth of English Porcelain," by Charles F. Binns were published in 1901.

In 1902, "The Foreign Scrapings" department was inaugurated under the editorship of George J. M. Ashby, who translated and briefed the more important articles appearing in foreign publications. Upon the death of Mr. Ashby, Samuel Geijsbeek became the editor of the department and has rendered most valuable service to the ceramic industry in this connection. "Opportunities of the Young Clayworkers of the Twentieth Century," D. V. Purington; "Experiences in Burning with Oil," W. D. Gates; "Clayworking Industries in Germany," A. V. Bleininger; "Lamination in Clays," George S. Tiffany; and the serials "Talks on Burning;" "Clay Dust" and "The Modern Clayworker," and "Plant Management and Plant Problems" were the most worthy articles in 1902.

In 1903, William Waplington contributed a valuable serial, "Theory of Draft and Chimney," which continued through that year and 1904, as well as a serial on "Theory of Drying." Other serials of that year were "Brickyard Experiences," by L. C. Moore, "Burning Brick with Producer Gas," by J. J. Koch, "Manufacture of Fire Brick," H. J. Quandt and "Brick and Bricklaying," by Owen B. Maginnis; "Slag Brick and Cement," A. V. Bleininger; "Watersmoking and Whitewash," J. J. Koch, "Special Refractories from Primary Kaolin" also appeared that year.

"The Rôle Played by Iron in the Burning of Clay Wares," by Prof. Edward Orton, Jr., was printed in full in 1904; "Kiln Atmosphere," "Salt Glazing," "Draft and Heat" and "The Cause of Crazing of Sewer Pipe," were four articles by Anton Vogt. The serial "Chemical Formulas as Used by Clayworkers," and such articles as "Relative Value of Fuel," by J. J. Koch; "Useful Properties of Clays," Harvey W. Wiley; and "Behavior of Iron in Clay When Burned to Viscosity," by George C. Matson, also appeared in 1904.

The year 1905 is credited with two fine serials by W. D. Richardson, which were afterward put in book form, and are still in demand; namely, "Burning Brick in Down Draft Kilns" and "Drying Brick."

"The Possiblities of Porcelain," C. F. Binns; "Trenton, the Staffordshire of America," J. Homer Stover; "Economy of Producer Gas for Burning Clay Ware," Lemon Parker, and the serials "Economical Generation and Use of Steam," W. D. Richardson, and "Fuel Values," J. J. Koch, appeared in 1906.

"The Effect of Heat upon Clays," by A. V. Bleininger, was a serial running through 1907 and 1908, that was later put in book form and had a tremendous sale. "Crazing of Glazed Ceramic Products," Karl Langenbeck, and "Tests Regarding the Melting Stages of Seger Cones" appeared in 1907.

In 1908, Walter A. Hull wrote a series of articles for the *Clay-Worker*

covering "The Use of Dampers" in two parts, "The Question of Draft," "Different Methods of Burning," and "Economy of Small as Compared with Large Plants;" Samuel Geijsbeek contributed "The Tunnel Kiln System in Use in the German Porcelain Industry," and W. D. Richardson, "The Layout of Round Kiln Crowns." "Use of Barium Compounds," Ellis Lovejoy, was reprinted from *Transactions of the American Ceramic Society;* "Controlling Dryers and Kiln Operations," A. V. Bleininger; "Making Front Brick without Repressing," R. T. Stull; and "The Manufacture of Enameled Brick," Ernest Hardy, were published that same year, having been read before the Illinois Clayworkers' Association.

"Gas Producers and Gas Fired Continuous Kilns," by J. J. Koch, was the most important of the serial articles in 1909. However, there were many valuable short articles including "The Use of the Draft Gauge," in two parts, and "Function of the Test Kiln," Walter A. Hull; "Sanitary Pipe Making," H. W. Hardy; "Rough Face Brick," Ellis Lovejoy; and "Air under Pressure as Compared with Natural Gas." Reprinted papers were "The Preparation of Surface Clays" (two parts), A. V. Bleininger; "Pyrometric Cones," J. M. Knote; "Method of Overcoming the Sulphur Problem," H. B. Wells; and "Salt Glazes of Surface Clays," L. E. Barringer.

"Economy in Brickyard Construction and Operation" was a serial by Ellis Lovejoy, started in 1909 and run through two years; was later published in book form, and is still in demand.

The 1910 volume of the *Clay-Worker* contains many fine articles, such as "The Manufacture of Clay Pots;" "Making Sanitary Ware and Salt Glaze Brick in England," Frank Hardy; "Importance of Labor Saving Devices," J. D. Pratt; "A Modern Pottery, Its Construction, Operation and Products," H. E. Ashley; "Japanese Ceramics," H. Shugio; "Polychrome Architecture from View Point of Clayworker," H. C. Mueller; and "Some Problems of the Clay Working Industry," Dr. I. A. Holmes. Convention papers, "A Lubrication Die for Hollow Ware," R. T. Stull; "Combustion of Fuel and the Application of Heat in Kilns," A. V. Bleininger; "The Function of Lime in Clays," A. V. Bleininger; and "Notes on the Manufacture of Enameled Brick," R. T. Stull; The Department of Recent Patents was inaugurated in 1910, and is still continued, giving a list of all patents of interest to clayworkers.

The articles of chief interest to ceramists in the 1911 volume of the *Clay-Worker* are "Making High Potential Porcelain Insulators," "Removal of Overburden by Hydraulic Sluicing," Paul Beer; "American and English Clay Methods," H. W. Johns; "Blistering of Stoneware Glazes;" "Melting Point of Clays" and "Fuller's Earth," Ellis Lovejoy. That year was also reproduced the splendid Bulletin by A. V. Bleininger, U. S. Bureau of Standards, "Effect of Preliminary Heating Treatment upon the Drying of Clays," in a seven part serial.

The 1912 issues of the *Clay-Worker* contained such articles as "Roofing Tile," a serial, which continued into 1913, by W. G. Worcester; "How Much Heat to Dry a Thousand Brick," a serial running through a part of 1913, by R. B. Hoehne; "Choice of a Kiln," W. D. Richardson; "Points of Construction and Operation of Lubricating Dies," R. T. Stull; "Pottery Making, American and English," C. F. Binns; "Gas from Gas Producers, and Its Combustion," J. J. Koch; "Drying of Clay Products," I. M. Justice; "Impressions of Clayworking Methods in Europe" (serial), A. E. Eaton; and "Making Terra Cotta Columns," H. W. Johns. Of even greater value this year was the series of articles of Ellis Lovejoy on "Drying Clay Wares," which continued through 1913, 1914 and 1915, was afterward published in book form, and has enjoyed an extensive sale throughout this country and Canada, being acknowledged a text-book on that subject.

The 1913 volume contains "Whitewash, Cause and Remedy," "How to Salt Glaze Sewer Pipe" and "Burning Brick in Common Up-Draft Kiln" (two parts), all by J. J. Koch. "Design of a Tile Plant with a View to Economical Construction and Operation," C. B. Harrop; "Harvested Thoughts on Drying Clay Ware," I. M. Justice, and "Factory Costs," J. L. Childs. The last three were convention papers.

In 1914, the *Clay-Worker* inaugurated the "Build with Brick" campaign, which scattered the slogan "Build with Brick" on signs, both metal and cardboard, all over the country and did much to arouse the brickmaking fraternity to the value of advertising and the people generally to the real value of burned clay products. The same year the *Clay-Worker* suggested the idea of holding prize competitions in the schools to gain additional publicity and start the younger generation to thinking in terms of clay products. "The Manufacture of Sewer Pipe" was an important series of articles by Anton Vogt which appeared in 1914. Other articles of interest to ceramists were "Economy of Continuous Kilns," William A. Butler; "Burning with Gas," J. J. Koch; "Burning Flash Brick;" "The Underwood System of Burning;" "Lamination, Its Causes and Remedy;" and "On the Burning of Rough Texture Shale Brick," Walter A. Hull, which was reprinted from *Transactions of the American Ceramic Society.*

The 1915 issues of the *Clay-Worker* contained "The Manufacture of Electrical Conduits;" "Leadless Glazes Used in Denmark;" "Things a Lump of Coal Can Do;" "The Value of Experiments;" "When Is a Kiln a Kiln;" "Dryer over Continuous Kiln;" "Ceramics in Illinois;" "Graphite Clay Products;" "Clay Products as an Engineering Material" (two parts), A. V. Bleininger, Bulletin of Bureau of Standards; "The Legal Interpretation of the Word 'Vitrified' as Applied to Ceramic Products," Prof. Edward Orton, Jr., from American Society for Testing Materials; "Purification of Clays," A. V. Bleininger, Convention paper.

In the year 1916, there appeared "The Problem of Pottery Clays;"

"Some Views of Clay Burning;" "Blasting Down Shale and Plastic Clays;" "Analyzing Clay and Physical Testing;" "Glazing Drain Tile;" "Washing of Clays," J. J. Koch; "Flashing Brick," Anton Vogt; "Practical Clay Testing;" A. Malinovsky; "Burning and Salt Glazing Tile," J. J. Koch; "Practical Tests," F. N. Menefee; "Future of Ceramic Education in America," Prof. Edward Orton, Jr., New Jersey Convention paper; "A Study of Atterburg Plasticity Method," C. S. Kinnison, U. S. Bureau of Standards Bulletin; "Properties of Some European Plastic Fire Clays" (four parts), A. V. Bleininger, and H. G. Schurecht, Bulletin U. S. Bureau of Standards. "The Manufacture and Use of Compounds of Barium," Emley and Young, U. S. Bureau of Standards; "Experiments to Overcome Scumming and Improve the Color of Brick," A. E. Williams, *Transactions of the American Ceramic Society;* "Production of Finer Grades of Stoneware from Illinois Stoneware Clays," R. R. Danielson for Illinois Convention.

Beginning in 1916 and continuing through 1920, there appeared in the *Clay-Worker* the most complete and pretentious serial article ever written for the clayworking craft, that of "Burning Clay Wares," by Ellis Lovejoy. The second edition has just been issued, and the book has been accepted as a text-book, being generally considered the best, most thorough and practical volume ever published for the ceramic industry.

During the year 1917, there appeared, "Plant Management (a serial), R. B. Hoehne; "Richardson Continuous Kiln," H. C. Arnold; "Producer Gas Fired Tunnel and Compartment Kilns," R. H. McElroy; "American Haigh Kiln," Lambert Haigh; "Economy in Kiln Crown Building;" "Rectangular versus Round Kilns;" "Ceramic Engineering," L. E. Barringer; "Preparation of Clays, Mining, Drying and Proper Mixing," W. W. Swengel; "An Improved Clay Dryer," W. W. Swengel; "Factors of Depreciation and Their Importance in Figuring Costs," J. E. Randall; "Casting Heavy Clay Products," Frank Riddle, U. S. Bureau of Standards; "Relation of Efficiency of Up-Draft and Down-Draft Kilns," J. D. Pratt, for the Wisconsin Convention; "Brickwork Tests and Formulas" (two parts), H. Kreuger—translated by G. Wson Cronquist; "Pug Mill, Its Use and Abuse," Robert Twells, U. S. Bureau of Standards; "Notes on the Crucible Situation," A. V. Bleininger.

"Report of Coöperative Brick Pier Investigation between National Brick Manufacturers' Association and the United States Bureau of Standards," J. G. Bragg, was published in 1918, as was "Economic Methods of Heating Clay Storage Sheds," C. Hartsell; "Strength of Sewer Pipe;" "Waste Heat from Continuous Kilns," W. D. Richardson; "Importance of Structure in Refractories," F. H. Riddle; "The Fuel Value of Various Coals, Oils, and Producer Gases," O. L. Kowalke; "Standard Tests of Refractory Materials," F. H. Riddle; "Suggested Means of Saving Fuel;" "Classification of Refractories," F. H. Riddle; "Hollow Tile as a Factor in

Fire Prevention," Walter A. Hull. "Fuel Economy in Burning Clay Products," A. V. Bleininger and A. F. Greaves-Walker, U. S. Bureau of Standards. "The Automatic Control and Measurement of High Temperatures," R. P. Brown, Faraday Society; "Advantages of Clay Storage and a Description of a Successful Installation," Frank H. Riddle, *Transactions of the American Ceramic Society.* "Recent Developments in Ceramics," A. V. Bleininger (2 parts), Institute of Metals.

Among the articles of importance in the year 1919, were "Resistance of Clays;" "Manufacture of Fire Brick in England," D. V. Lowe; "Industrial Research;" "Magnesite in Refractory Work;" "Slags and Their Relation to Refractories," F. H. Riddle; "The Use of Refractories;" "Hot Blast Stoves;" "Basic Refractories for the Open Hearth," J. Spotts McDowell and Raymond M. Howe; "Designing of Factory Layouts for the Clay Industries," T. W. Garve, *Transactions of the American Ceramic Society.* "The Work of the Ceramic Experiment Station," R. T. Stull, United States Bureau of Mines; "Notes on Flow of Clay through Hollow Ware Dies," G. D. Morris, *Transactions of the American Ceramic Society.*

In 1920, the *Clay-Worker* printed "Pointers on Plant Management" (serial), W. D. Richardson; "To Determine the Quantity of Brick in a Circular Kiln Crown;" "Manufacture of Spark Plugs;" "Dimensions of Round Down-Draft Kilns;" "Fuel Economy in Coal Buying;" "Equalization Tables," by Ellis Lovejoy; "Pottery Making in Japan;" "Some Causes for Fire Brick Failures;" "An Exemplary Porcelain Insulator Factory;" "Refractory Oxides on Which Progress Depends;" "Storage and Handling of Raw Clays," T. W. Garve, *Transactions of the American Ceramic Society.*

In the 1921 volume of the *Clay-Worker,* we find such articles as "Observations Taken from Some Railroad Tunnel Kilns;" "Modern Development of the Direct Fired Type of Railroad Kiln;" "Modern Brickmaking in South America" (two parts); "Temperature at which China Ware is Burned;" "The Muffle or the Direct Fired Tunnel Kiln;" "Tunnel Kiln Truths;" and "The Tunnel Kiln in the Brick Industry."

The above compilation of titles is but a small part of the ceramic literature found in the *Clay-Worker* during these past twenty-five years. We have not included either the great mass of valuable material to be found in the reports of the National Brick Manufacturers' Association convention published every year. Nor are other articles mentioned which have appeared in the various departments, which are handled by capable writers, in the interest of the heavier clay products, such as paving brick, hollow ware, drain tile, etc. Therefore, the above gives but a slight idea of the real value of the *Clay-Worker* to the clay products manufacturers of the nation.

Theodore A. Randall, president of T. A. Randall & Co., publishers of the

Clay-Worker, is the editor and manager of the magazine, and in token of his work and efforts, both personally and through the columns of the *Clay-Worker* in behalf of the AMERICAN CERAMIC SOCIETY, was made a life member of that organization at the St. Louis convention in 1907.

James E. Randall, Secretary-Treasurer of T. A. Randall & Co., and junior editor of the *Clay-Worker*, is an active member of the AMERICAN CERAMIC SOCIETY.

"BRICK AND CLAY RECORD:" ITS HISTORY

BY F. L. STEINHOFF

Just call to mind any industry, the steel, power, chemical, automobile, engineering or electrical, and if you will follow its history and that of the business paper identified with it, you will notice a marked similarity in the progress and development of each. There is this one constant point of difference, however. The successful business paper is always a step ahead of the progress of its industry. The business paper does not keep pace with the industry but the industry follows in the light of the business paper's teachings—for this is one of the prime reasons for its existence.

As important as the church and school are to the nation's spiritual and cultural development, just so essential is industrial publishing to American industry. "There is no teacher whose work is more essential in the progress of our commercial and industrial world," said E. N. Hurley, former head of the United States Ship Building Corp., speaking of the industrial press, "no reporter whose news is of more permanent interest to its readers. It is a most valuable adjunct of industry and is a necessary and important tool to the manufacturers, the merchants and business men in general."

The point of these statements may be summed up as follows: If you want to know the history and enterprise of a business paper, just note what development has taken place in the industry itself.

Many of you have turned through the pages of such highly esteemed publications as the *Iron Trade Review* and *Iron Age* in the steel industry, *Power and Power Plant Engineering* in the power plants, *Chemical Age* and *Chemical and Metallurgical Engineering* in the chemical industries. Their leadership in gathering and spreading information of special interest to their readers, their functions as a clearing house for trade ideas and business policies in their field, their promotion of the interests and technical development in the industries they serve—these energetic, persistent and consistent activities were largely responsible for the progress of their respective industries.

Just as other business papers have had a prominent part in the unfolding of their industries, so has *Brick and Clay Record* played a similar rôle in the technical as well as business advancement in the ceramic industries; particularly in those branches whose products enter into the construction of buildings, pavements, drainage systems, and iron and steel furnaces.

Thirty years ago clay products were largely made by processes as crude as those in use twenty centuries before. This is not true today and, while the surface of development in the clay industry has barely been scratched, one cannot express aught but amazement at the remarkable development that has taken place in recent years. It is an astounding fact that certain branches of the clay industry have made greater progress in the last thirty years than in the previous three thousand. The mechanical setting of brick, mechanical loading of brick onto motor trucks, car tunnel kilns, motorization of the industry, automatic stokers on kilns, humidity dryers, shale planers, conveying systems for unloading kilns, automatic brick machines, are only a few of the many new labor saving and cost cutting ideas that have come into use in the past thirty years.

It was during these same thirty years that *Brick and Clay Record* was developing from an infant magazine into a publication whose statements carried international weight. Its standing in the industry which it serves is unique in that its ratio of readers to the number of establishments is as high, if not higher, than that of the highest ranking business paper in any other field. This extremely high measure of good-will which it has acquired is directly due to the progressive stand it has always taken in the interest of the industries it serves.

It would be easy to fill a book with the reasons why *Brick and Clay Record* has played such an indispensable part in helping the clay products industry to achieve its present high plane of development. Briefly, a few of the special enterprises and activities it has fostered are summed up below:

Brick and Clay Record was first to recognize the lack of proper merchandising methods in the clay products industry, which was the cause of thousands of dollars loss annually. Ideas for better distribution were outlined and sponsored.

It has always fought for and advocated wide publicity instead of silence for all clay products as a weapon against the great inroads made in its market by substitute materials. The wisdom of this course was appreciated and now there is hardly a clay product which does not broadcast its message throughout the entire country.

Wherever an appropriate field existed for a trade association *Brick and Clay Record* has encouraged the formation of such associations even to the extent of using its own funds to assist organization. The folly of leaving one organization to take care of the interests of all the various

products was finally recognized some years ago and strong associations formed in each separate branch of the industry. Tremendous benefits have resulted from this reorganization of the industry.

The disreputable practice of price cutting as well as profiteering has been vigorously discouraged.

Brick and Clay Record has always admonished manufacturers that substitute materials would take away their markets if cost, and therefore prices, were not kept low—to this end it has persistently inspired plant betterments and blazed the way to improved methods. Its columns have been a forum for the discussion of important problems and a clearing house for ideas from every part of the world.

Editorial representatives of *Brick and Clay Record* have visited the most distant parts of the country to investigate and give light to the latest developments in machinery, equipment and manufacturing methods, thus enabling the entire industry to profit by the highest development of any part.

The establishment of standardized shapes and sizes has always been fostered and coöperation whole-heartedly and liberally given.

Realizing that an over-capacitated industry is always highly unstable and unsound, *Brick and Clay Record* has invariably discouraged the construction of new plants at points where neither material nor market existed.

To eliminate as much as possible the enormous mortality rate of 11% in the clay industry, the dire need for knowing costs has been urged consistently. Good cost systems which have been described in its columns have enabled manufacturers to establish fair prices.

As a distinctive assistance, aside from its regular service, *Brick and Clay Record* has counselled and informed manufacturers on thousands of technical, sales, accounting, legislative and other important problems and policies.

To aid in the stabilization of the market *Brick and Clay Record* has published from time to time the current prices of many of the commodities manufactured in the field.

News of what the various concerns in the industry are doing in the way of installing new machinery, adopting new methods of production, sales, accounting, and so forth, has been a distinct help to brother craftsmen in the clay products industry by providing a source of contact with the industry.

Brick and Clay Record has always been an independent paper, unprejudiced and unbiased, has never permitted itself to be officially adopted as the mouthpiece of any organization but it has been endorsed by practically all of the many trade and technical associations represented in the clay products industry.

The germ of thought of industrial research, such as is now being carried on by four prominent clay product associations and collaborated in by the AMERICAN CERAMIC SOCIETY, the United States Bureau of Standards and the United States Bureau of Mines, found its origin in the editorials and preachments of *Brick and Clay Record.*

Some of the best books published on American methods of producing ceramic ware have been published by *Brick and Clay Record* from time to time and are now found as a standard equipment on nearly all progressive plants. "How to Analyze Clay," by Holden M. Ashby, published and distributed by *Brick and Clay Record,* was one of the first helpful books for the clay manufacturer who desired to know methods that could be adopted to determine the value of his clays.

"Clay Working Problems," published by *Brick and Clay Record* in 1915, was a selection of 101 questions from more than 500 addressed to the editorial office of *Brick and Clay Record.* These were questions asking for practical information on vital and practical problems daily confronting the manufacturer. Questions were answered by men who were considered authorities and the problems, together with their answers, published in book form. It has been a valuable contribution because of its unique and very practical character, to the literature on clay manufacture.

"Scientific Industrial Efficiency," written by Dwight T. Farnham and published in 1917, has been acclaimed as one of the best books ever published for a special industry. Its author is one of the most renowned industrial engineers in America and not only is a member of the AMERICAN CERAMIC SOCIETY, but is well known throughout its entire organization.

"Clay Plant Instruction and Operation," by A. F. Greaves-Walker, published by *Brick and Clay Record* in 1919, has saved thousands of dollars for prospective and veteran clay manufacturers throughout every section of this country and Canada. Mr. Greaves-Walker, previous to preparing this volume had a broad experience in the manufacture of nearly every clay product in a wide variety of sections in both the United States and Canada. Both his diversified experience and ability has contributed to make this volume one of indispensable aid to the manufacturer.

"Clay Products Cyclopedia," published in 1922 is the most recent product of *Brick and Clay Record.* It contains 752 definitions of processes, materials and pieces of equipment of direct interest to clay manufacturers. It also contains a statistical section including the most vital and essential data required in the manufacture of clay products and a catalog section giving descriptions of the most important equipment and machinery required in the industry.

This book was the first attempt ever made to compile in a brief and compact form, the wealth of information pertaining to clay products manufacture which is scattered in the many journals, magazines, books and

catalogs published on the subject and the knowledge of those of long experience in the varied fields of clay manufacture.

Brick and Clay Record itself is the result of the amalgamation in 1910 of two publications, "Clay Record" and "Brick." "Clay Record" was established in 1891 and "Brick" three years later in 1894. In uniting, these two journals were placed on a better basis. In the early days of the publication only three persons gave their full time to its editing, circulation and business. At the present time, because of its enlarged activities, twenty-one persons are required in its editorial, circulation and business departments besides twenty men scattered throughout various sections of this country and two in foreign countries, gathering news and other data of special interest to the manufacturer of clay ware. From a paper of purely local interest its subscription list has extended to include readers in nearly every country in the world; its articles are often reprinted in many foreign journals.

Brick and Clay Record has made a host of friends in the industry; it is proud to report that its friends have increased and become more intimate each year. It is only natural in publications that some disagreement in policy would manifest itself at times, but this has occurred so infrequently that it has been almost negligible.

However, the friendships and esteem that *Brick and Clay Record* has built in the industry were not established upon the personalities of any of its personnel, but upon the more sound and business-like basis of its value as an institution and a source of constructive ideas and policies. For the same reason the paper has constantly grown in esteem and influence.

In volume No. 1 of "Brick" an editorial stated "The magnitude and extent of the clay industries combined to constitute one of the most important business interests of this country, so that with a constant improvement in methods and enlargement of scope there are created new needs and requirements. To these advanced ideas 'Brick' will be especially devoted. It will be at once practical, progressive and entertaining, and it will be our constant pleasure to make each succeeding issue better and more attractive." As it has in the past, *Brick and Clay Record* will continue in the future to subscribe to these ideals and to devote its interests to making "each succeeding issue better and more attractive."

"THE GLASS WORKER" AND "CHINA, GLASS AND LAMPS"

By John M. Hammer

Two weekly journals published in Pittsburgh for the past 40 years in the service of branches of the ceramic industry are *The Glass Worker* and *China, Glass & Lamps*. The first, as its name implies, is dedicated to the

glass industry in all its departments. *China, Glass & Lamps* is a medium standing between the general ware and art pottery fields and the glassware industry and those who distribute such wares in various ways. The history of these journals is similar to that of most other trade organs which have survived the strenuous competition of 20 years or so ago.

The Glass Worker in its more than 40 years has undergone several changes of name. In striving to keep pace with the growing and changing glass industry, it also has changed in appearance and editorial content, attempting to meet the present needs of the industry it serves insofar as its editors sense those needs. Being a trade journal, it tries today to be of service as fully as it can to all the branches of the glass industry. The technical side is neither lost sight of nor centered upon to the extinction of regular trade news.

The two journals named are published by the Commoner Publishing Co., chartered under the laws of Pennsylvania. *The Glass Worker* is issued each Saturday and *China, Glass & Lamps* on Monday of each week.

In addition to the publication of two journals serving what are really two distinct fields, the publishers, through *The Glass Worker*, have given to the glass industry three books of a practical technical nature which have a world-wide circulation. The latest, "American Glass Practice," written by Harry Bastow, a man of experience as a glass manufacturer and consultant, is a treatise covering the practical side of glassmaking. Modern problems are discussed in the light of experience and practical formulas are presented. The book is intended for the intensive use of practical glassmakers. "Chemical Analysis for Glassmakers" by Edward C. Uhlig, B.S., contains methods of analysis for raw materials that enter into the manufacture of glass and other products based on silicates. It is illustrated and is planned for the practical chemist. "Elements of Glass and Glassmaking" by B. F. Biser, is for the practical glassmaker and includes facts and formulas of use in the manufacture of window and plate glass, containers, flint glass and colored glass.

China, Glass & Lamps covers broadly the china and porcelain tableware and utilitarian pottery fields and table and ornamental glassware with special reference to their distribution at both wholesale and retail. Virtually unaided, it fought for many years for adequate tariff protection for American dinnerware manufacturers. This and the purveying of technical and semi-technical news to the general ware pottery industry have been its largest contact between the producer and the seller.

The business management of the journals for many years has been in the hands of J. G. Kaufmann well known to glass and pottery manufacturers. At present, the editorial management of the two journals is in charge of John M. Hammer, a trained newspaperman. He specializes on the

pottery and glassware industries. George J. Eibel, Jr., has been connected with glass industry trade journals for nearly 30 years and is in direct editorial charge of *The Glass Worker*. He has a wide acquaintance in the glass industry and a knowledge which only 30 years of the closest contact can give. A veteran of both journals is Henry W. Gauding, formerly in editorial charge of each of the weeklies. An experienced glass man, Mr. Gauding gives a practical touch to the editorial staff.

"CHEMICAL AND METALLURGICAL ENGINEERING"

By Alan G. Wikoff

About three years after the foundation of the American Ceramic Society, a small group of men who had been active in the organization of the American Electrochemical Society met in Philadelphia to consider the question of establishing a technical journal devoted to the interests of the rapidly developing electrochemical industry. As a result of this conference, the Electrochemical Publishing Company was formed, with Dr. Joseph W. Richards, late professor of metallurgy at Lehigh University, as president, and Dr. E. F. Roeber was chosen editor of the new monthly, *Electrochemical Industry*, which made its first appearance in September, 1902.

From this the present *Chemical and Metallurgical Engineering* has developed by a series of logical steps. It was soon found that presentation of developments in electrochemistry and electrometallurgy in their proper perspective involved consideration of allied industrial fields. The enlarged editorial scope was indicated in 1905 by a change in name to *Electrochemical and Metallurgical Industry*. Further extension was reflected in another change in 1910 to *Metallurgical and Chemical Engineering*. In 1912 the entire stock of the Electrochemical Publishing Company was acquired by the McGraw Publishing Company. Greatly increased service to the industry was made possible by semi-monthly publication which began in September, 1915. During the War, a great impetus was given to the profession of chemical engineering and it was thought advisable to emphasize this development by rewording the title in July, 1918, to *Chemical and Metallurgical Engineering*. A little more than a year later—in October, 1919—publication was placed on a weekly basis in order that it might be possible to give readers more timely information regarding important happenings. During the twenty years of its existence, *Chemical and Metallurgical Engineering* has witnessed many profound changes in the industries which it serves and because of its ability to sense these changes and to assist in guiding them in the right direction, it has been able to maintain its leadership in this field.

This outline would be incomplete without brief mention of the McGraw-Hill Company, since Mr. McGraw was interested in *Chemical and Metallurgical Engineering* from the start. This company resulted from the consolidation of the two leading engineering publishers, the McGraw Publishing Company and the Hill Publishing Company.

James H. McGraw gained his first experience in the publishing business with the American Railway Publishing Company of New York, then owner of Street Railway Journal. This periodical was acquired and renamed *Electric Railway Journal* by Mr. McGraw in 1888, after the dissolution of the publishing company. An electrical paper purchased in 1896 was consolidated with two others acquired in 1899 to form the *Electrical World*. To control these enterprizes the McGraw Publishing Company was incorporated in 1899, with Mr. McGraw president and controlling stockholder. In 1902 *Engineering Record* was added and during the same year Mr. McGraw lent his aid and influence to the foundation of the Electrochemical Publishing Company, the development of which has already been discussed. *Electrical Merchandising* and *The Contractor* complete the list.

John Alexander Hill became a publisher with the acquisition of *Locomotive Engineering*, after having been several years on its editorial staff. Under his direction the publication became a success, but it was sold and in 1902 the Hill Publishing Company was formed by consolidation of the American Machinist Press, publisher of the weekly, *American Machinist*, and Power Publishing Company, which owned the monthly, *Power*. Subsequent additions include: *Engineering and Mining Journal*, 1905; *The Engineer*, a semi-monthly, consolidated with *Power* to form a weekly in 1908; *Engineering News*, 1911; *Coal Age*, a weekly, started in October, 1911, and consolidated with *Colliery Engineering* in 1915.

Although the book companies affiliated with these two organizations had combined in 1909 to form the McGraw-Hill Book Company, consolidation of the two publishing firms did not take place until after the death of Mr. Hill, 1916. At the present time the company publishes thirteen engineering and industrial journals—eleven in New York, one in Chicago, one in San Francisco and the European edition of *American Machinist*, in London.

After the death of Dr. Roeber in 1917; Mr. H. C. Parmelee, who had been western editor since 1910 (with the exception of one year during which he served as president of the Colorado School of Mines) became editor. Under his direction the editorial staff has kept pace with the development of the broader editorial scope, and it is now by far the largest of any periodical in this field, numbering eleven men. They are: H. C. Parmelee, editor; Ellwood Hendrick, consulting editor; Ernest E. Thum, associate editor; J. S. Negru, managing editor; Alan G. Wikoff, R. S. Mc-

Bride, Sidney D. Kirkpatrick, A. E. Buchanan, Jr., Graham L. Montgomery, Charles Wadsworth, 3rd, Charles N. Hulburt, assistant editors. From the very nature of the field covered, it is evident that *Chemical and Metallurgical Engineering* has always been directly interested in certain phases of the ceramic industry. Indeed, the first issues of the paper contained information regarding processes used at Niagara Falls for the manufacture of electrochemical products which are now widely used as refractories. Being in close contact with users of refractories, it was possible to encourage research and process improvement in this field by supplying the true facts regarding the behavior of refractories under service conditions. With the possible exception of boiler installations, there is hardly a field for the application of refractories which is not treated in *Chemical and Metallurgical Engineering*.

Other ceramic topics which have received considerable attention are: glass technology and research; manufacture and application of chemical stoneware; production of chemical porcelain; fused silica.

Within recent years, particular attention has been given to the meetings of the AMERICAN CERAMIC SOCIETY, complete reports of these being prepared by one of the editors who is a member of the SOCIETY. Plants visited during the summer meetings have also been written up. It is felt that this work has been helpful in bringing the accomplishments of the AMERICAN CERAMIC SOCIETY and the problems of the ceramic industry to the attention of a diversified group of interested technical men.

Turning to the books which have been published by the McGraw-Hill Book Company (which, it should be noted in passing, maintains an organization and offices separate from, although affiliated with, the publishing company) much the same condition is found to exist that was referred to in connection with the journal. With the exception of Havard's "Refractories and Furnaces" most of the books have dealt with ceramic materials from the point of view of service conditions. Here again the field has been thoroughly covered particularly as regards refractories. Without going into detail to the extent of attempting to cite the individual books, it is evident from the following list of subjects that few fields of application have lacked consideration: Boilers; gas producers; coke ovens; electric furnaces; general metallurgy; blast furnace construction; metallurgy of iron and steel; smelting of copper, lead, zinc and tin; cement manufacture; petroleum refining.

In closing this brief review, it may be stated that the editorial policy of *Chemical and Metallurgical Engineering* calls for still closer contact with the ceramic industry so that increased service may be rendered in the years to come.

CHICAGO, ILLINOIS

"THE GLASS INDUSTRY"

By J. B. Krak

The Glass Industry claims the distinction of being the first monthly technical publication (other than official organs of technical societies) devoted to glass technology, manufacturing practice, raw materials, factory management and related subjects, and conducted in accordance with modern publishing practices. This claim can be made only by a narrow margin. The first issue of *The Glass Industry* appeared in November, 1920. Two months later a similar publication in the French language was started in Belgium.

Indeed the time was ripe for the establishment of a technical paper concerned exclusively with glass manufacturing. The past twenty years have witnessed all over the world a tremendous expansion of every line of industry. This applies especially to the United States. Coincident with this great industrial development has been the growth of industrial publishing. Here also the United States has led. In this country the technical papers have become the acknowledged leaders of the industries with which they are identified. Official recognition was given to the technical press during the War when editors of engineering publications were frequently called upon to confer with heads of the various government agencies. Some of the prominent men in the industrial publishing field were drafted for war service and rendered invaluable assistance in solving the many technical and economic problems of that period.

Glassmakers have realized for some time that there was a need for a technical journal in their industry. They frequently voiced the opinion that the glass industry would derive substantial benefits from a periodical conducted upon modern lines, treating principally of the technical and practical manufacturing problems of glassmaking and giving to this phase of the industry the same earnest attention and study that similar problems in other industries receive from their journals.

The publishers of *The Glass Industry* recognized the unusual opportunity of establishing a technical paper in a field practically untouched. They realized that the glass industry is at the beginning of a new era of expansion. When confronted with the demand for a modern technical publication to cover the glass industry they accepted the challenge.

The Glass Industry, now beginning the third year of its existence, has met with the cordial responsiveness of practically all who have become acquainted with its plans and purposes. Glass makers have quickly appreciated the value of a publication having the object to provide a medium of information through which they can keep themselves abreast of the latest developments, invention and thought in glass engineering and research, the best practice in melting, annealing and other operations.

The Glass Industry stands for adequate scientific control of the various

processes of glass making. It aims to publish the opinion of experts on tank design and operation, gas producers and fuel problems, batch ingredients, refractories and the numerous other subjects related to the problems, large and small, with which the glass manufacturer is at all times confronted.

The Glass Industry is independent of all special interests. It is controlled only by its publishers, men of long experience in the technical publishing field. Its work is to collect from every reliable source all the useful ideas and accurate information available and to present them to its readers in plain understandable fashion. Its columns are open to all who have any useful facts or ideas to offer to their fellow workers in glass.

The publishers and editors subscribe to the code of ethics that has been adopted by the national associations of business publications and industrial editors. They are pledged to consider first the interests of the subscribers, to present the news of the industry free from personal bias and to determine the policies of the paper independently of advertising considerations.

Having established *The Glass Industry* as a medium of technical information and discussion, the publishers feel that the journal can grow to its fullest degree of usefulness only through the hearty coöperation of the *men who know.*

Grateful acknowledgment is made of the splendid assistance rendered by many of the leading technical men of the glass industry. The continuance of such support from manufacturers, technical experts and practical workers alike is required to make *The Glass Industry* what it aims to be, an agency of progress in the field of glass manufacturing.

HISTORY OF THE "NATIONAL GLASS BUDGET"

By A. W. Kimes

The National Glass Budget was established in 1884 by Michael J. Owens and a number of other associates and was then known as the "Ohio Valley Boycotter." The publication retained this name but a short time, changing to the present title at the time of its removal to Pittsburgh in the late '80s, where it has been published continuously thereafter. Soon after coming to Pittsburgh the *Budget* was published by Timothy O'Leary. In 1887, George B. Kimes became associated with the paper and later acquired complete ownership. Under his guidance it became internationally known in the glass industry as a most dependable and fearless exponent of fair dealing between employer and employee, and in the discussion of issues vital to the life and welfare of the glass trade. For

more than a decade Frank M. Gessner was editor of the *Budget* and his fearless editorial remarks, always presented with the best interest of the industry in mind, were severely criticized by those advocating selfish principles. After Mr. Gessner's death, which occurred in 1906, George

GEORGE B. KIMES

ARTHUR W. KIMES

B. Kimes assumed the editorship as well as management, in which capacities he continued until the time of his death on May 30, 1919. He was prominently known in all branches of the glass industry and it can truthfully and justifiably be said of him, as well as Mr. Gessner, that in their respective positions they had no close competitors. Since 1909, Arthur W. Kimes had been associated with his brother George and upon the latter's demise became managing editor, with Thomas A. Kimes as secretary. These two latter gentlemen are the present owners and publishers. For more than 27 years prior to 1922, George J. Eibel, Jr., was associated with the *Budget* in various capacities.

The National Glass Budget was severely censured and criticized during the '90s for advocating the introduction of mechanical means in the art of glassmaking but, hewing true to the line, it stood firmly for what it then believed and since has proven to be correct, that the glass industry in order to keep pace with other lines of trade would necessarily be compelled to progress from manual to machine methods of manufacture. Holding fast to this belief, the *Budget* is now published on the same principle, advocating those policies that are best for all those interested in the manufacture and distribution of all kinds of glass and glassware.

To the *Budget* belongs the credit for having first written up practically every new innovation in the way of glass manufacturing machinery and predictions made have become a reality.

A SHORT HISTORY OF "ROCK PRODUCTS"

By C. F. Darling

Rock Products was founded in Louisville, Kentucky, in 1902, by E. H. Defebaugh. This was the same year that the Portland Cement Association was founded, and each of the two organizations recently celebrated their twentieth anniversaries. In the year following, 1903, Mr. Defebaugh called together the first meeting of lime producers, which resulted ultimately in the formation of the National Lime Association, now a large and prosperous association.

Up to 1902 the field covered by *Rock Products* had been practically unrecognized, and while it was even then large and important as a basic industry, the growth of the past twenty years has been remarkable.

Rock Products was founded with an objective that has always been consistently maintained—"The mission of *Rock Products* is to serve the trade in any and every honorable way possible, to promote better profits and make life more pleasant for those engaged in the business to which it caters."

Nathan C. Rockwood

With the first editor and publisher, Mr. Defebaugh, became associated some time later, Fred Irvine as editor, and the two became well known in the industry. In 1907, the publication offices were moved to Chicago, where they have been ever since. In 1917, the property was sold by the original owners to the Tradepress Publishing Corporation, and in December, 1917, Nathan C. Rockwood, formerly an editor of the *Engineering News*, became editor of the magazine. In the past five years Mr. Rockwood has made the industry the object of his special study, and has devoted his whole-hearted efforts to the improvement of the paper. He has given the paper a definite editorial policy and has built it up until it is recognized as the authoritative journal of the gravel, stone, slate and other allied industries, as well as of the cement, lime and gypsum industries.

Rock Products treats particularly of the production and manufacture of these products, but inasmuch as these are industries in which it is impossible to separate the technical from the business, *Rock Products* has become to this industry what *Iron Age* is to the iron and steel industry, a technical, business and statistical medium and guide.

The character of *Rock Products* was radically changed in 1917 and 1918 when it was taken over by the present owners. Founded originally as

a producer's paper, in the course of ten years it lapsed into an attempt to cover the whole field of both production and distribution. Under Mr. Rockwood's direction, the field of distribution was eliminated in the editorial contents so far as the appeal to dealers only was concerned and the paper has since stood as one edited entirely for the producers and manufacturers of the non-metallic mineral industries.

A BRIEF HISTORY OF "CHEMICAL ABSTRACTS"

By E. J. Crane

Chemical Abstracts, a semi-monthly journal published by the American Chemical Society, was started in 1907. It may be considered the outgrowth of a project inaugurated by Arthur A. Noyes in 1895 for the purpose of gathering together abstracts of chemical papers published in this country. The *Review of American Chemical Research* was the name of this earlier publication. It was discontinued when *Chemical Abstracts* was started. William A. Noyes was the first editor of *Chemical Abstracts;* he was at that time also editor of the *Journal of the American Chemical Society*. To him much credit is due for the organization of the work. He was followed in 1908 by Austin M. Patterson who continued as editor until 1914. John J. Miller, who served as associate editor for several years, was editor during a part of 1914. He left this work soon after his appointment as editor and the editor from 1915 up to the present time has been E. J. Crane. Many of America's most prominent chemists have served or are serving as assistant editors or abstractors. About two hundred and fifty abstractors are on the staff of the journal.

Chemical Abstracts is not restricted in the field it covers to chemical papers published in America but makes every effort completely to abstract the current chemical literature of the world, including patents. New books of interest to the chemist are also listed, with references to reviews when reviews can be located. The industrial side of chemistry receives the same attention that is given to theoretical papers. Some notion of the magnitude of the current chemical literature can be obtained by noting the number of abstracts published in a single year in *Chemical Abstracts*. In 1921, 19,476 abstracts were published, 15,211 of which were taken from journal articles and the remainder from patents. These, with the indexes cover 4,949 pages or an average of 206.2 pages per number.

Special attention is given to the indexing, particularly the subject indexing. The annual index number with its separate author, subject and formula indexes, can be used with confidence as a key to the whole of the literature of chemistry for the period covered. A collective index

to the first ten volumes (1907–1916) has been published. It consists of two volumes devoted to authors, 1,980 pages, and two volumes devoted to subjects, 2,843 pages.

An effort is made to have each abstract prepared by a chemist who is a specialist in the particular field involved. Quality of abstracts is further safe-guarded by the editorial supervision of men of high standing in their branches of chemistry who serve as Assistant Editors, one or more being in charge of each of the thirty sections into which the abstracts are classified.

While most of the abstracts are prepared in this country a few are obtained by coöperative arrangement with the two British chemical societies, namely, The Chemical Society and the Society of Chemical Industry. A coöperative arrangement with the *Journal of the American Ceramic Society* is also in effect, working to the advantage of both journals.

OHIO STATE UNIVERSITY
COLUMBUS, OHIO

"JOURNAL OF INDUSTRIAL AND ENGINEERING CHEMISTRY"

The *Journal of Industrial and Engineering Chemistry*, as its name implies, covers the broad field of the application of chemical science. In its columns are found contributions from the laboratories of practically every university and industrial research organization in America. This material covers a wide range of subjects, for example, dyes and textiles, the metals, leather, cellulose, rubber, fertilizer, petroleum, agriculture and food, medicinal products, sanitation, etc. Some papers are written from the engineering point of view; others point out the industrial application of discoveries in pure science; while a third group deals with analytical processes or new laboratory apparatus. From time to time features appear such as statistical surveys of the chemical industries of other countries, articles from such laboratories as that of the Chemical Warfare Service, or articles and bibliographies by writers, expert in the subjects treated. Monthly letters from correspondents in Washington, London and Paris are included. Each issue covers reports of meetings of scientific bodies, general news items, notes from the industrial field, changes in business connections, personal notes, etc. Government publications in the technical field, reviews of new books, a list of recent journal articles, and chemical market conditions are summarized. A special feature of the *Journal of Industrial and Engineering Chemistry* is the editorial pages.

This *Journal* has taken first rank as an advertising medium in the industrial and engineering chemistry fields and is edited by H. E. Howe.

"THE JOURNAL OF THE AMERICAN CHEMICAL SOCIETY"

The *Journal of the American Chemical Society* is now in its forty-third year of continuous publication. Starting with yearly volumes of only a few hundred pages, it has increased until recent volumes contain nearly 3,000 pages;-and this in spite of the relief afforded by the establishment of *Chemical Abstracts* in 1907, and of the *Journal of Industrial and Engineering Chemistry* in 1909. With it was incorporated, in 1914, the *American Chemical Journal.*

Today, most of the contributions to pure chemistry made and published in America, appear in its pages. Many foreign chemists, too, in increasing numbers find it advantageous to publish accounts of their investigations in this *Journal.* In addition to these records of research, the *Journal* contains the Proceedings of the Society, and numerous reviews of books on pure chemistry and related subjects. No scientific library and no person interested in the progress of theoretical, physical, inorganic, organic, pharmacological, or biological chemistry can afford to be without it.

The *Journal* published monthly in numbers of about 250 pages each, is edited by Arthur B. Lamb and an efficient staff of associate editors.

RESEARCH LABORATORIES

OUR FEDERAL, STATE, SEMI-PUBLIC INSTITUTES AND INDUSTRIAL LABORATORIES

The Federal Bureaus.—From the beginning, this SOCIETY has advocated and in every legitimate manner worked for the establishment of ceramic divisions in the Federal bureaus. Records show that this SOCIETY initiated the first organized efforts to obtain the necessary enactments and appropriations.

The benefits to the ceramic industries from coöperative relations with the federal bureaus in scientific research is rapidly becoming universally acknowledged. The federal bureaus differ in character from the collegiate departments, but their academic contributions in trained men and in fundamental knowledge have been of no less value.

The Semi-public Institutes.—The Geophysical Laboratory of the Carnegie Institute in Washington, D. C., and the Mellon Institute in Pittsburgh enjoy world-wide renown for their contributions to science—the Geophysical Laboratory because of original work and fundamental scientific observations in fused magmas; and the Mellon Institute for the development of and results obtained from the industrial fellowship method of coöperation in research.

The Research Council.—The very brief and wholly inadequate account of the National Research Council here given recites the purpose and some of the achievements of that organization. It is of especial importance, we believe, to stress the fact that the Research Council was a creation of the industrial leaders in this country because of the need felt for coördination of the several industrial enterprises and the several research agencies. It is significant that the most successful and progressive manufacturing concerns not only maintain extensive research organizations of their own, but have recognized the importance of giving liberal support to universities, federal and state research organizations, and have recognized the importance of coördinating the efforts of the several scientific, technical and trade associations in research.

The Chamber of Commerce of U. S. A.—Through this national organization, the tradesmen and the manufacturers nationally are being prompted to coördinated efforts on problems of safety, elimination of waste, etc., but no service rendered by this Chamber has a greater value than its promotion of technical investigation and pure science research by Trade Associations.

CERAMIC INVESTIGATIONS CONDUCTED BY THE STATES AND THE FEDERAL GOVERNMENT

By A. V. Bleininger

The States

The earliest interest in the systematic study of the ceramic raw materials and processes was shown by the geological surveys of a number of states, and the first more elaborate report was that on the clays of New Jersey, by Dr. Cook, in 1878, published by the Geological Survey of New Jersey. In this contribution the chemical composition of the clays was given much consideration and the physical structure of the clay particles was discussed very ably. Following the appearance of this report comparatively little was done for some time with the exception of an occasional paper here and there and a number of contributions to the Institute of Mining Engineers. But in the beginning of the nineties a revival of interest in clays occurred, which was marked by the reports of H. Ries on the quartenary clay deposits of the Hudson river valley, N. Y. Geol. Rept. No. 10, 1891; of Edward Orton, Sr., on the clays of Ohio and Edward Orton, Jr., on the clay working industries of Ohio, 1893. The last named report was the first to give a connected story of the industrial processes and the principles involved as understood at that time. From this time on in rapid succession many reports on clays appeared, published by as many states, most of which were written by Dr. Ries. Thus we have publications from the states of New York (1892 and 1902), Missouri (1896), Mississippi (1896), North Carolina (1897), Pennsylvania (1898), Indiana (1897 and 1904), Georgia (1898, 1907 and 1908), Louisiana (1899), Kansas (1898), Florida (1900), Alabama (1900), Michigan (1900), Wisconsin (1901) Maryland (1902), Iowa (1904), New Jersey (1904), Kentucky (1905), West Virginia (1906), Virginia (1906), North Dakota (1906), Illinois (1907), Oklahoma and Minnesota. A number of these reports, particularly that of H. A. Wheeler for Missouri, those of Ries for New Jersey and Maryland, of Beyer and Williams for Iowa, of Buckley and Peppel for Wisconsin, of Grout for West Virginia and of Purdy for Illinois, contain original contributions dealing with the technology of clays, of considerable and permanent value.

A bibliography of the official literature on the geology of clays would be very extensive. Most of the reports are restricted to the geological classification and description of the deposits although many of them contain brief summaries of the chemical composition and the physical properties of clays as well as descriptive matter relating to the ceramic industries of the state. One geological survey, that of Ohio, under the directorship of Edward Orton, Jr., departed widely from this custom and published reports which are complete treatises on specific industries. This is true of

the bulletins on the manufacture of lime and sand-lime brick by Peppel, on the use of concrete by Eno, on the manufacture of hydraulic cements by Bleininger and on the manufacture of roofing tile by Worcester. The Ohio Geological Survey is still following this policy in part as is also the Geological Survey of Illinois. The latter, for instance, in its volume on the paving brick materials of the state, by Purdy, presents the results of extensive laboratory investigations.

The quality of the many state reports differed quite widely and in some of them both the methods of testing and the results obtained were subject to criticism. Frequently the work was fragmentary and the conclusions drawn were of no practical value to the industries. This lack of unity and correlation in the ceramic work of the state surveys created the feeling that there was needed a federal institution which could do fundamental work in the study of the properties of ceramic materials, in the formulation of testing methods and in the interpretation of the results obtained. Such investigations would be entirely too costly to be undertaken by any single state survey. The AMERICAN CERAMIC SOCIETY was the first to see the need of this and its secretary, Prof. Edward Orton, Jr., did a large amount of work in bringing about the realization of the plan. He not only appealed to the officials of the U. S. Geological Survey and to Congress as early as 1899, but took active steps to secure the coöperation of the different state surveys. He also called a conference for the discussion of the technical work needed to be done which met in Columbus in 1907. The result of this activity was the establishment of a ceramic laboratory within the Technologic Branch of the U. S. Geological Survey in 1908.

The U. S. Geological Survey

This remarkable Federal organization has for many years contributed geological reports dealing with the sources of ceramic materials, many of them from the pen of Dr. Ries. It had also been collecting statistics of all the mineral industries, including a well-organized section devoted to ceramics under the direction of Jefferson Middleton. It realized the need of specific investigations outside of the strictly geological field which would deal with the technology of the key industries, making use of the rocks and minerals of the country. This need was emphasized particularly by Dr. Joseph A. Holmes who devoted all of his energies to the establishment of federal laboratories devoted to such work. In 1904, we find a congressional appropriation for the analyzing and testing of coal for which purpose a laboratory was established at the Louisiana Purchase Exposition in St. Louis. In 1905, an appropriation of $227,000, covering the study of all fuels and another appropriation for the study of structural materials, was made. A laboratory for the testing and the study of cement and concrete

was likewise equipped at St. Louis, under the direction of Richard L. Humphrey. The first chemist to enter this work was P. H. Bates. The fuel work was conducted at St. Louis until 1907 and the structural materials investigations until 1909. In 1907, the Technologic Branch of the U. S. Geological Survey was created, with Dr. Holmes as Chief Technologist. In 1908 the Pittsburgh station was established on the grounds of the Allegheny Arsenal, 40th and Butler Sts. At this time part of one of the buildings was reserved for ceramic work and a clay products section established in charge of A. V. Bleininger. With him were associated H. E. Ashley and, in 1909, G. H. Brown. A kiln house was erected and the equipment gradually increased as the activities of the laboratory expanded. The work consisted in the testing of materials from the public domain and for different government departments, and research. The first investigational work undertaken dealt with the work of Ashley on the colloidal matter in clays, the effect of preliminary heating on clays and the standardization of the load test for refractories. Much work was also done on the mechanical strength of clay products. Of special interest was the study of the colloid phenomena of clays in which Ashley considered deflocculation and coagulation to be the results of direct chemical reactions between chemical compounds and the finely dispersed portion of the clays, a viewpoint recently advocated by Loeb. In 1909, the structural laboratory was removed from St. Louis to Pittsburgh and with it the work on concrete and cement testing. It was at this time that Bates did his work on the effect of soluble salts on concrete. Investigations were also undertaken on the properties of lime and the problems of the lime industry with the assistance of W. E. Emley who later became chief of a section devoted to the study of lime and gypsum products.

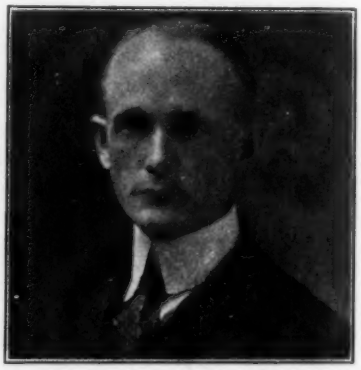
The rapid growth of the Technologic Branch and the need of a separate Bureau devoted to the interests of the mining industries resulted in 1910 in the creation of the Bureau of Mines with Dr. J. A. Holmes as its first director. By the same act of Congress the investigational work on structural materials was transferred to the Bureau of Standards. Under this Bureau the researches on ceramic subjects proceeded without interruption.

The Bureau of Standards

This Bureau at once undertook the erection of the ten million pound testing machine provided for by the Technologic Branch which made it possible to conduct tests on a large scale and with which there were made later important tests on concrete columns and brick piers. Before the transfer, the Bureau of Standards had done investigational work on bricks and refractories which was continued. At this time Bates began his studies on the fundamental properties of Portland cement and their correlation

with its microstructure, with the assistance of A. A. Klein, the petrographer of the station. All of the ceramic activities were expanded as more funds became available. The death of H. E. Ashley in 1911, however, caused all colloidal research to be abandoned, with the exception of several practical applications which he had pointed out in his work. Emley continued the investigation of lime, its properties, the technology of the lime industry and of sand-lime brick, publishing a number of bulletins and papers on these subjects. G. H. Brown undertook the study of the properties of paving brick in relation to their life in the street, tests of the toughness of clays, the dehydration of clays, the function of time in the vitrification of clays, the effect of mixtures of clay on vitrification, the resistance of refractories to pressure, their resistance to slagging action, the production of synthetic slag bricks, the properties of porcelain bodies and he reproduction of the Marquardt porcelain body for pyrometer tubes. Brown was first to make tubes of this kind from American materials. He also was chiefly instrumental in preparing the pottery exhibit of the Bureau for the San Francisco Exposition which was awarded a gold medal. In this he was assisted by W. W. McDanel who was in immediate charge of the pottery laboratory. It should be mentioned perhaps that Brown installed the use of the Keppeler caustic soda process for the purification of kaolin in a plant near Saylorsburg, Pa., in 1914.

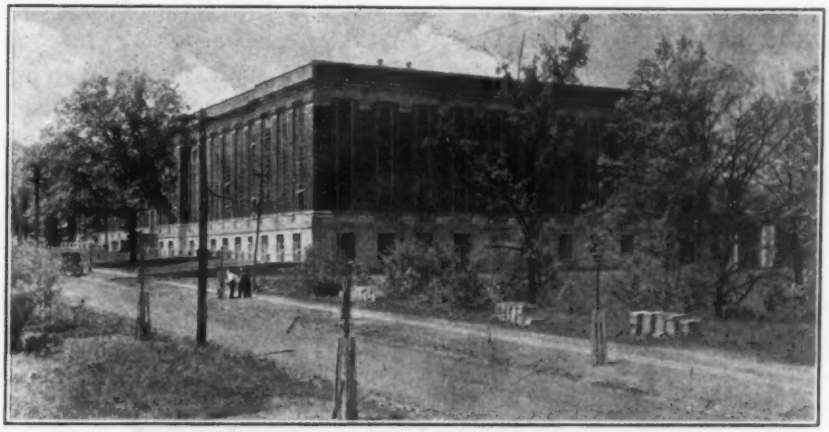
Dr. S. W. Stratton



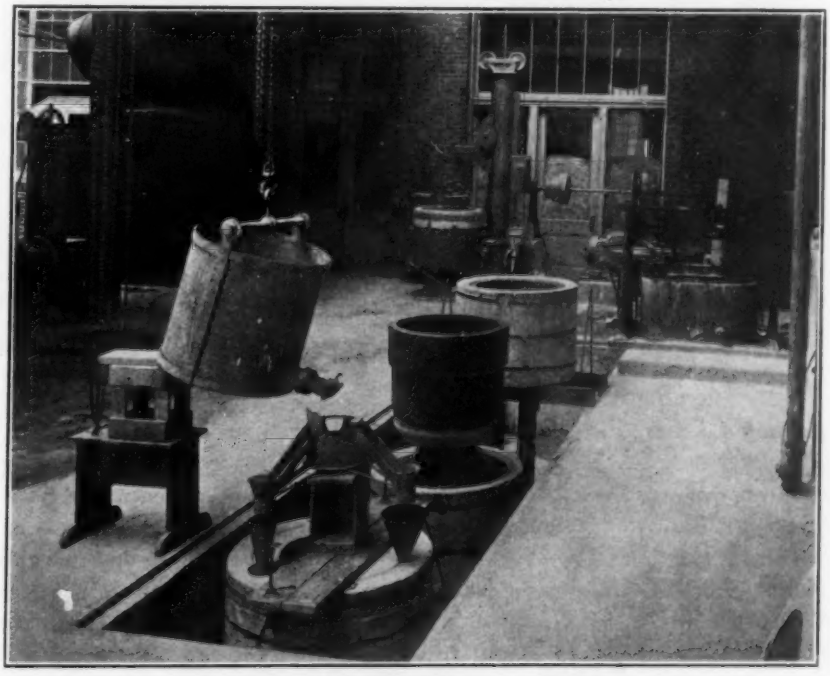
Dr. H. Foster Bain, Director U. S. Bureau of Mines.

Bleininger, with Kinnison, worked on the study of the Schwerin electrical process for the purification of kaolin, with Teetor on the viscosity of porcelains, with Brown on the mechanical strength of burned clay, with Hornung on the casting of clay slips, etc. A. A. Klein contributed an important paper on the microstructure of porcelain, E. T. Montgomery one on leadless glazes for vitreous ware, W. L. Howat

applied the use of sodium sulphate in an artificial freezing test and again Montgomery worked on the composition of bodies, resisting thermal shock, D. W. Ross undertook at this time the study of silica refrac-



Industrial Building, containing ceramic laboratories, Washington, D. C.

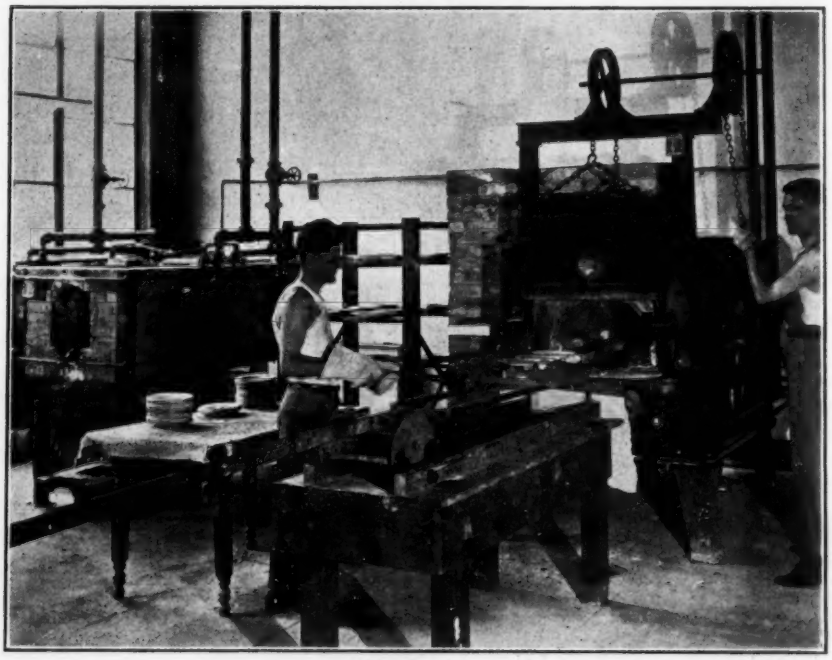


Glass pot casting shop, Bureau of Standards.

tories from the ceramic and Peck, Insley and Klein from the petrographic standpoint.

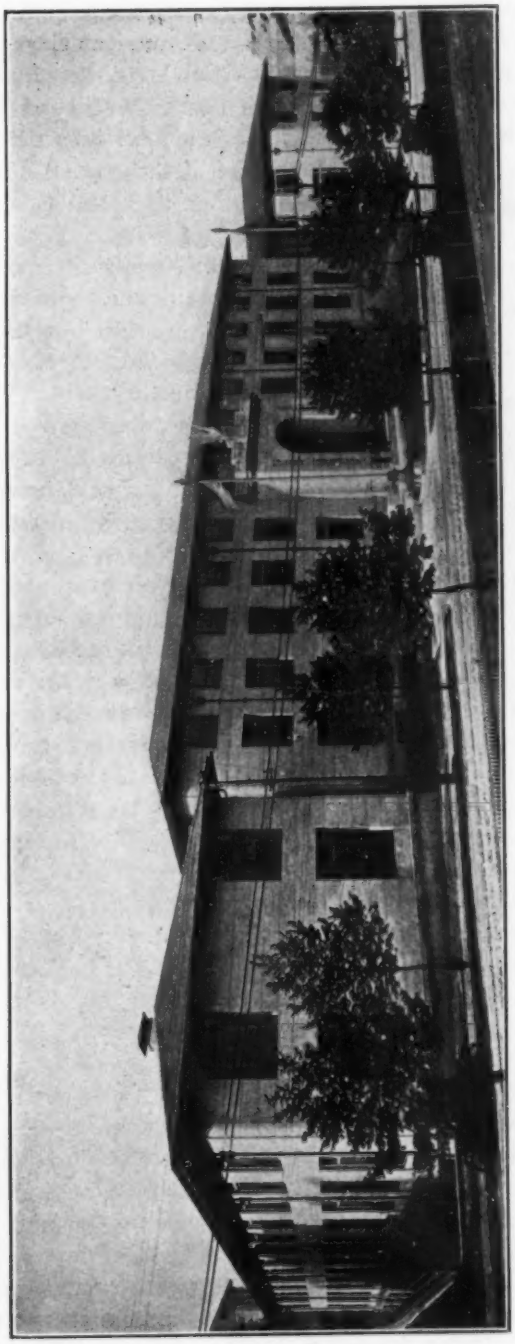
The fire resistance laboratory established at Pittsburgh, under the direction of W. A. Hull, contributed a number of studies of ceramic interest, particularly in reference to the flow of heat in large size test structures.

In 1914, the study of the melting of optical glass was undertaken on a laboratory scale, in charge of C. C. Rand and later of A. E. Williams. Work was also begun on the investigation of European bond clays (Bleininger and Schurecht), on the properties of the American bond clays (Bleininger and Loomis) and the heat behavior of American fire brick (Loomis). At a later date F. H. Riddle, who had taken the place left vacant through the resignation of Prof. Brown, began his extensive investigation of porcelain, both from the laboratory and the factory standpoint.



Enameling laboratory, Bureau of Standards.

During the War the work on optical glass was expanded and two glass plants built, one in Pittsburgh and another in Washington, with A. E. Williams in charge. A number of other problems, such as the production of special spark plug porcelains (by Bleininger and Riddle), the production of pyrometer tubes, the pressing and casting of porcelain glass pots, light weight refractories for marine use, the molding of optical glass (Capt. Fry),



Division of Fuels, U. S. Bureau of Mines, Pittsburgh, Pa.

the testing of optical glass (Taylor and Payne), the properties of commercial porcelains (Wright and Sewell), the use of American clays in the manufacture of whiteware (Bleininger and McDanel), etc. were undertaken.

During the war period H. F. Staley became associated with the Bureau as metallurgical ceramist and as ceramic adviser with the War Industries Board. Later he was appointed chief of the refractories and enameled metals sections. In addition to his other work Riddle served as district chief of the Fuel Administration, Furnace Section.

A special appropriation made it possible to erect in Washington a large building for industrial research which contains ample provision for the work on clay products, glass, lime, gypsum, enameled metals and cement. The floor space devoted to ceramics has an area of 43,800 sq. ft. It is probably the largest structure of its kind in the world. From the last of the year 1919, to May, 1920, the ceramic work was removed from Pittsburgh to Washington, where it is now permanently located. In the new building the various activities are being carried on under much more favorable conditions than at Pittsburgh. The glass section particularly possesses exceptional facilities.

Ceramic investigation is making steady progress at this Institution. The work by Danielson on enameled metals has been important as has been that of Bates on magnesia cements, of Hull and Geller on refractories, Sortwell on porcelain glazes, Geller on water-smoking and dehydration, etc.

A system of fellowships has also been established in coöperation with a number of industries. The fellowships now operating are supported by the following organizations: The National Terra Cotta Society, the Hollow Building Tile Association, the four Heavy Clay Products Associations, the Glass Containers Association, the Associated Tile Manufacturers and the U. S. Potters' Association.

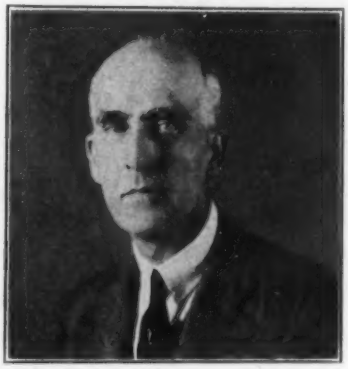
The ceramic work of the Bureau of Standards is under the general direction of P. H. Bates and under the direct charge of W. A. Hull, chief of the clay products and glass sections. R. R. Danielson is chief of the enameled metals section and A. E. Williams is in charge of the work on industrial glass.

The Bureau of Mines

This Bureau was established by act of Congress, effective July first, 1910. In its creation the membership of the AMERICAN CERAMIC SOCIETY took an active part, especially through the efforts of Prof. Edward Orton, Jr.

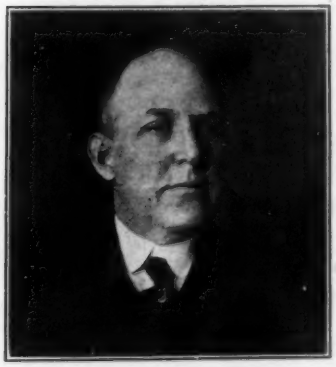
The new Bureau began its ceramic work by the appointment of Prof. A. S. Watts who took charge of the field work on the resources and the mining of the kaolins and feldspars of the southern Appalachian region, in 1911. This work resulted in the publication of a comprehensive and valuable report on the subject, known as Bulletin No. 53. The laboratory work

necessary in this investigation was started by Watts at the Ohio State University with a small force. In 1911–12 some work was done also in the ceramic department of the University of Illinois by Robert Back, who later was transferred to the Washington laboratory of the Bureau. This study dealt principally with the effect of electrolytes on clays, the results of which were published in the *Transactions*. Back also began the study of the Keppeler process of purifying clays by the use of caustic soda.



DR. R. B. MOORE, chief of Division of Mineral Technology, U. S. Bureau of Mines.

In 1913, H. G. Schurecht joined the staff at the Columbus laboratory where he worked for some years, first under the direction of Watts and later of R. T. Stull. Schurecht contributed a large number of papers on ceramic subjects among which may be mentioned his work on the effect of electrolytes upon clays, the designing of very useful voluminometers, the design of a machine for the determination of the crushing strength of heated fire brick, elutriation tests of American kaolins, the effect of wet grinding and screening feebly plastic clays, the burning of dolomite, dolomite cements, the separation of the lime from the magnesia in fired dolomites, the microscopic examination of American kaolins, the effect of the firing temperature on the strength of clays and ceramic bodies, the properties of some Ohio and Pennsylvania fire clays, decorative lusters for pottery, aventurine glazes, etc.



DR. D. A. LYON, chief Metallurgist, U. S. Bureau of Mines.

Ira E. Sproat was detailed by the Bureau to study the purification of kaolins by means of caustic soda and utilized the process on a large scale at a Georgia mine. The results of this work appeared as a Bureau publication. Another very practical contribution was that of T. G. McDougal which dealt with the plant aspect of the casting process. Both of these studies were conducted under the supervision of Watts.

In 1917 the ceramic station of the Bureau of Mines at the Ohio State University was established with R. T. Stull as the superintendent. Under his direction the equipment was greatly enlarged and the staff increased. During the War the Bureau was called upon to study

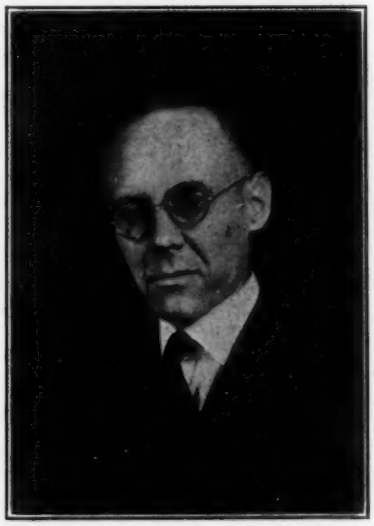
the graphite crucible situation relating to the use of American clays and graphites. This question was of great importance in connection with the production of munitions. A very elaborate and complete investigation was begun which after a great deal of painstaking work showed conclusively that American materials could be used successfully.

JOHN BLIZARD, Fuel Engineer, U. S. Bureau of Mines, Pittsburgh, Pa.

A number of papers dealing with subjects relating to this problem have come from the Bureau, dealing with the fusibility of graphite ash, the fusibility of mixtures of clay and graphite ash, the properties of crucible clays, the briquetting of Alabama graphite by means of tar, and the behavior of crucibles made from Ceylon, Canadian and Alabama graphite, tested out under actual operating conditions.

As part of the national program on war minerals the Bureau also undertook the study of American white burning clays which might be suitable for the manufacture of pottery, a most comprehensive undertaking. In this connection Stull invented a new type of washing process which he demonstrated on a semi-commercial scale. Additional contributions not already mentioned are those on the dead burning of dolomite and magnesite (Schurecht), on the properties of bentonite (Schurecht and Douda), the properties of refractory clays from California, the mechanical movement of water through clays and

A. C. FIELDNER, Supt., Pittsburgh Station.



G. A. BOLE, Supt., Ceramic Experiment Station U. S. Bureau of Mines

its control, the purification and analysis of zirconium oxide (Jackson), plasticity from the colloidal standpoint (Bole), and the design of an improved porosimeter (Bole).

In 1921, the Bureau of Mines, in coöperation with the Hollow Building Tile Association, the Common Brick Manufacturers' Association, the American Face Brick Association and the National Paving Brick Manufacturers' Association undertook an elaborate and comprehensive study of

Ceramic experiment station personnel, U. S. Bureau of Mines.

Standing left to right: R. C. Zehm, F. G. Jackson, E. P. Ogden, G. A Bole, R. T. Stull, H. M. Kraner, P. S. Bachman, A. H. Fessler.

Sitting left to right: J. T. Robson, L. E. Geyer, Hazel I. Gibbon, R. T. Watkins, A. V. Henry, R. B. Gilmore.

the burning of the heavy clay products. In this investigation the Bureau also coöperates with the Bureau of Standards which carries on certain laboratory work. Part of the study dealing with the fundamental question of heat absorption has been assigned by the Bureau to E. W. Washburn. The field work, consisting in the study of the actual firing processes in various types of plants, is being conducted jointly by the Columbus station and the Fuels Division of the Bureau. Nearly 30 plants have been studied from this standpoint and the possible fuel economies have been actually demonstrated. This unique work has been greatly assisted by the use of a laboratory railroad car, operated by the Bureau, which is fully equipped and is used to take a staff of six men and their apparatus from place to place. This work which has been done under the close supervision of Stull, when completed, will undoubtedly yield a complete survey of the present

burning processes and definite recommendations towards the reduction of fuel losses.

The Bureau has established also a ceramic station in coöperation with the University of Washington, at Seattle, in charge of Hewitt Wilson, which conducts studies of the raw materials of the Pacific Coast.

In 1922, R. T. Stull was promoted to the position of Supervising Ceramist of the Bureau of Mines and was placed in charge of all ceramic research. G. A. Bole was appointed superintendent of the Columbus station and with him is associated E. P. Ogden as ceramic engineer.

RESEARCH COUNCILS

By E. W. Washburn[1]

I. The National Research Council of the United States

The National Research Council was first organized in April, 1916, at the request of the President of the United States and during the War it acted as the Department of Science and Research of the Council of National Defense. In May, 1918, the President issued an Executive Order in which he stated that, "The work accomplished by the Council in organizing research and in securing coöperation of military and civilian agencies in the solution of military problems demonstrates its capacities for larger service." The Executive Order further requested that the National Research Council be perpetuated with duties which were set forth as follows:

> The National Research Council was organized in 1916 at the request of the President by the National Academy of Sciences, under its Congressional charter, as a measure of national preparedness. The work accomplished by the Council in organizing research and in securing coöperation of military and civilian agencies in the solution of military problems demonstrates its capacity for larger service. The National Academy of Sciences is therefore requested to perpetuate the National Research Council, the duties of which shall be as follows:
>
> 1. In general, to stimulate research in the mathematical, physical, and biological sciences, and in the application of these sciences to engineering, agriculture, medicine, and other useful arts, with the object of increasing knowledge, of strengthening the national defense, and of contributing in other ways to the public welfare.
>
> 2. To survey the larger possibilities of science, to formulate comprehensive projects of research, and to develop effective means of utilizing the scientific and technical resources of the country for dealing with these projects.
>
> 3. To promote coöperation in research, at home and abroad, in order to secure concentration of effort, minimize duplication, and stimulate progress; but in all coöperative undertakings to give encouragement to individual initiative, as fundamentally important to the advancement of science.

[1] Chairman, Division of Chemistry and Chemical Technology, National Research Council.

4. To serve as a means of bringing American and foreign investigators into active coöperation with the scientific and technical services of the War and Navy Departments and with those of the civil branches of the Government.

5. To direct the attention of scientific and technical investigators to the present importance of military and industrial problems in connection with the war, and to aid in the solution of these problems by organizing specific researches.

6. To gather and collate scientific and technical information at home and abroad, in coöperation with governmental and other agencies and to render such information available to duly accredited persons.

Effective prosecution of the Council's work requires the cordial collaboration of the scientific and technical branches of the Government, both military and civil. To this end representatives of the Government, upon the nomination of the National Academy of Sciences, will be designated by the President as members of the Council, as heretofore, and the heads of the departments immediately concerned will continue to coöperate in every way that may be required.

The White House, May 11, 1918. (Signed) WOODROW WILSON.

In the permanent form given to the Council, it consists of three classes of representatives: first, those of national scientific and technical societies; second, representatives from different branches of the government; and third, representatives from other research organizations. The Council is made up of two general classes or divisions: (*a*) those divisions concerned with the more general relations and activities of the Council and (*b*) those concerned with particular branches of science and technology. Under the first class, there are six divisions: namely, Division of Federal Relations, Division of Foreign Relations, Division of States Relations, Division of Educational Relations, Division of Research Extension and Research Information Service. The divisions of science and technology comprise Physical Sciences, Engineering, Chemistry and Chemical Technology, Geology and Geography, Medical Sciences, Biology and Agriculture, and Anthropology and Psychology. More particularly, the purpose of the Council consists in the promotion of research in the mathematical, physical and biological sciences and in the application of these sciences in engineering, agriculture, medicine and other useful arts. In carrying out its work, the Council endeavors particularly to avoid duplicating the efforts of other organizations having similar objects and strives to utilize to the fullest extent existing facilities for research wherever located.

The Council has been entrusted by various foundations, organizations and individuals with the expenditure of large sums contributed in support of special projects and, owing to the nature of its organization and the success which it has had in the past, it seems probable that this branch of its activities will continue and will be materially increased in the future. Among such trust funds may be mentioned two grants of $500,000 each in support of national research fellowships in chemistry and physics and in medicine.

The AMERICAN CERAMIC SOCIETY is officially connected with the Council through the Division of Chemistry and Chemical Technology to which it nominates one member. Mr. A. V. Bleininger has served in this way as the representative of the SOCIETY since the permanent organization of the Council. Early in the history of the Division of Chemistry and Chemical Technology, the Division invited the AMERICAN CERAMIC SOCIETY to join with it in the creation of a Committee on Ceramic Research. This committee was appointed and served until last year when, at the suggestion of the SOCIETY, the committee was discharged since the reorganization of the SOCIETY's activities provided otherwise for the work which had been carried on by the committee.

The Council is at all times ready to assist the scientific societies of the country in furthering and developing any worthy project connected with research. Through its Division of Research Information, it also stands ready at any time to supply individuals with information or sources of information concerning all topics connected with scientific investigation.

Among the publications of the Council the following may be of interest to the members of the SOCIETY:

Report of the committee on ceramic chemistry. Presented for the Com. by E. W. WASHBURN, *chairman*. Washington, April, 1919. Pp. 6. No copies for distribution.

Report of the Com. on Ceramic Research joint committee with the AMERICAN CERAMIC SOCIETY, with reference to a plan for the establishment of a system of research fellowships in ceramics supported by the industries. Submitted by ALBERT V. BLEININGER, *chairman*. November 19, 1919. Pp. 9. No copies for distribution.

Industrial research and national welfare. By GEORGE E. HALE. Reprinted from *Science*, N. S., November 22, 1918, **48,** 505–507. Limited supply distributed free, post. 1 c.

Industrial research and national welfare. By ELIHU ROOT. Reprinted from *Science*, N. S., November 29, 1919, **48,** 532–534. Limited supply distributed free, post. 1 c.

The national value of scientific research. By GEORGE E. HALE. Reprinted from *The Technology Review*, November, 1916, **18,** 801–817. Distributed free, post. 1 c.

The organization of research. By JAMES R. ANGELL. Reprinted from the *Journal of Proceedings and Addresses of the Association of American Universities*, Twenty-first Annual Conference, November 7 and 8, 1919. Pp. 27–41. Distributed free, post. 1 c.

The organization of research in our American democracy. By JAMES R. ANGELL. Preprinted from the *Proceedings of the Institute of Medicine of Chicago*. March 5, 1920. Pp. 18. Distributed free, post. 2 c.

The obligation of the state toward scientific research. By JAMES R. ANGELL. Reprinted from the *Centennial Memorial Volume* of Indiana Univ. July, 1921. Pp. 12. Limited supply distributed free, post. 1 c.

The new opportunity in science. By R. A. MILLIKAN. Published in *Science*, N. S., September 26, 1919, **50,** pp. 285–297. No copies for distribution.

America's place in industrial research. Address given at the decennial celebration, Forest Products Laboratory, Madison, Wisconsin, July 23, 1920, by H. E. Howe. Pp. 18. Limited supply distributed free, post. 2 c.

Research in America after the war. By R. A. MILLIKAN. Reprinted from the *Transactions of the American Institute of Electrical Engineers*, 1919, pp. 129–140. Distributed free, post. 1 c.

The research spirit in everyday life of the average man. By JOHN C. MERRIAM. Reprinted from *Science*, N. S., **52**, pp. 473–478, November, 1920. No copies for distribution.

The national importance of scientific and industrial research. By GEORGE ELLERY HALE and others. October, 1919. Pp. 43. Price $0.50.

Periodical bibliographies and abstracts for the scientific and technological journals of the world. Compiled by R. COBB. June, 1920. Pp. 24. Price $0.40.

Funds available in 1920 in the United States of America for the encouragement of scientific research. Compiled by CALLIE HULL. March, 1921. Pp. 81. Price $1.00.

Research laboratories in industrial establishments of the United States, including consulting research laboratories. Originally compiled by ALFRED D. FLINN. Revised and enlarged by RUTH COBB.

Report of the Patent Committee of the National Research Council. Presented for the Committee by L. H. BAEKELAND, Acting Chairman. February, 1919. Pp. 24. Price $0.30.

Refractory materials as a field for research. By EDWARD W. WASHBURN. January, 1919. Pp. 24. Price $0.30.

Industrial research. By F. B. JEWETT. 1918. Pp. 16. Price $0.25.

The development of research in the United States. By JAMES ROWLAND ANGELL. November, 1919. Pp. 13. Price $0.25.

Science and the industries. By JOHN J. CARTY. February, 1920. Pp. 16. Price $0.25.

A reading list on scientific and industrial research and the service of the chemist to industry. By CLARENCE JAY WEST. April, 1920. Pp. 45. Price $0.50.

The relation of pure science to industrial research. By JOHN J. CARTY. October, 1916. Pp. 16. Price $0.20.

Industrial benefits of research. By CHARLES L. REESE and A. J. WADHAMS. February, 1921. Pp. 14. Price $0.25.

II. National Research Councils in Other Countries

Following the example of the United States, a number of other countries of the world have set up organizations having purposes more or less similar to those of our National Research Council. Thus, in Great Britain the Department of Scientific and Industrial Research was organized as a branch of the Government with purposes essentially identical with those of our National Research Council. Similar organizations have also been created in the following countries: In Australia, the Commonwealth Advisory Council of Science and Industry; in Canada, the Advisory Council for Scientific and Industrial Research; in New Zealand, the National Advisory Council on Research; in Italy, a National Research Council; and in Japan, a National Research Council. Similar organizations are also under consideration or in process of formation in other countries.

III. The International Research Council

Through the initiative of the National Academy of Sciences of the United States, there has been established an International Research Coun-

cil with headquarters at Brussels. This international body is composed of representatives of the research councils, or similar bodies, in the various countries. It is organized upon divisional lines very much as our National Research Council, its divisions being called unions; thus, for example, the division of chemistry is called the International Union of Pure and Applied Chemistry. These divisions have their own officers and are largely autonomous. The International Research Council meets triennially but many of the unions meet at more frequent intervals. Through the work of the unions, a large measure of international coöperation on research on scientific questions having international aspects has been inaugurated and, owing to the frequent meetings of these unions, they serve as a convenient channel for international scientific relations. The delegates to the international meetings of the International Union of Pure and Applied Chemistry are appointed by the National Research Council upon recommendation of its Division of Chemistry and Chemical Technology, and the AMERICAN CERAMIC SOCIETY has the privilege of nominating delegates to these meetings.

SERVICE IN WASHINGTON

What the Chamber of Commerce of the United States of America is Doing for the Industry[1]

National Chamber of Commerce

Visitors to Washington, the Nation's Capital, will soon have an opportunity of visiting a new building, which will be numbered among the most beautiful and substantial structures in that city of beautiful buildings. The Chamber of Commerce of the United States is now constructing a national home for organized business, which it is hoped will typify in appearance the dignity and stability of American commerce and industry.

This organization had its birth in a realization of the necessity for American business to have efficient and organized representation at the Nation's Capital to render assistance to the President, the Congress and the various Government Departments on all matters concerning the industrial welfare of the Nation.

Organized in 1912, the National Chamber has for almost 11 years been the guardian of the interests of American business. No piece of legislation, however small or unimportant, which is national in its scope, escapes the attention of the Chamber. It will be readily realized that the

[1] Contributed by the Fabricated Production Department, Chamber of Commerce of the U. S.

members of our national law making body called upon to deal with such a wide variety of problems cannot individually make complete preparation to meet all of these problems. It was to provide an organization capable of supplying the necessary facts and information, free from political or partisan influence and of unbroken continuity, that the Chamber was created.

This organization has grown steadily until it now consists of over 1300 organization members and more than 13,000 associate and individual members, representing an underlying membership of about 767,000 firms and individuals in all the 48 states, our insular possessions and several foreign countries. This growth led to such an increased demand for service that the Directors of the National Chamber, some three years ago, organized its activities by departments to provide a means of rendering real service in solving the problems confronting the various groups of American business men. These departments are headed by managers and supported by staffs who have been trained through practical experience and are experts in their respective lines. They are constantly furnishing in printed form and by letters and telegrams the results of impartial studies of their experts.

E. W. McCULLOUGH, manager, Fabricated Production Department, Chamber of Commerce of U. S. A., Washington, D. C.

These representative departments, cross sections of American business, are: Civic Development, Domestic Distribution, Fabricated Production, Finance, Foreign Commerce, Insurance, Natural Resources, Production and Transportation, and Communication.

Each of these departments serves as a channel through which the problems of their clientèle are investigated and thrashed out, then brought before the Board of Directors of the Chamber for consideration, if desirable. If the problem is national in scope it is brought before the entire membership of the Chamber to secure the opinion and, if that opinion be favorable, the support of all American business to the plans which have thus been analyzed and passed upon. By such departmentalization provision is made for an intensive study of the problems peculiar to each division of business. An intimate relation is established between each department and the interest it is particularly charged to represent so that in technical matters or in functions that overlap, all divisions of industry can be brought together through the same machinery (referendum), for ascertaining the opinion of American business, which has been found so effective and beneficial during the past ten years.

The Fabricated Production Department, one of the eight principal divisions of the Chamber, has for its field of service the investigation and solution of the common problems of manufacture. It has been working closely with the various lines of the ceramic industry and has given its support to many constructive undertakings within the industry.

In order that there may be no confusion between the scope of activities of the Fabricated Production Department and the Natural Resources Production Department, in both of which the ceramic industry has an interest, it would be well to clarify the line of demarcation separating the two departments. It is, therefore, considered that after raw materials or natural resources have received their first treatment in fabrication, *i. e.*, when ore is converted into pig iron, logs into lumber, cotton ginned and baled, etc., all problems arising thereafter in their further conversion into merchantable commodities will come within the scope of the Fabricated Production Department. It will be seen from this that insofar as ceramics is concerned practically all of its problems lie within the field of service of this department.

The policy and function of the Fabricated Production Department, determined by the Manager and his Advisory Committee, is to deal with these common problems of manufacture in an educational way, coöperating with its members in the study of their problems and aiding them through information obtained by research and the interchange of experiences. It has no desire nor intention to duplicate the work of government or other bureaus which are now rendering adequate service, but aims to coöperate with them in a manner that will aid in strengthening and upbuilding them. Problems may be brought to the attention of the department by organizations, by associate or individual members direct, or through the organizations of which they are members. In order that the department may have certain definite objectives to develop in its working plans, the following principal activities have been selected for special attention: (1) Cost Accounting, (2) Standardization and Simplification, (3) Business Statistics, (4) General Production Problems of a nature too indefinite to permit of classification.

Cost Accounting

There is no problem confronting manufacturers today of greater or more vital importance than that of the use of proper methods of cost accounting. A former Chairman of the Federal Trade Commission, a few years ago, made the statement that 80 per cent of the manufacturers of the country did not have correct information as to the costs of the products they produced. Whether one agrees with this statement or not, it is clear that no permanent success can be attained in manufacturing without proper attention being given to costs.

To deal with this subject adequately there has been formed within the Fabricated Production Department a very efficient Cost Accounting Bureau in charge of a cost expert. This Bureau has investigated almost every line of industry, both organized and unorganized, and has in its files some 120 systems of Cost Methods which have been adopted by the various lines. A progress chart was recently prepared showing the industries or commodity lines in which uniform cost accounting has been achieved or attempted, and it is interesting to note that the major portion of the progress of cost accounting work in the United States has been in recent years.

The various branches of the ceramic industry have all made use of the services of the department in the cost accounting field, but so far in only two of them, the face brick and the refractories manufacturers, has a definite uniform system been devised and installed. The latter group, the Refractories Manufacturers, has gone further and formed, within their organization, a Cost Accountants Institute where the accountants of their members may meet and discuss the latest developments in the cost accounting field.

The Common Brick Association has asked for and used some of the publications of the department, and it is hoped that in the near future some constructive steps towards a uniform cost system will be taken by that group. In like manner the Paving Brick Manufacturers have used the literature of the department, and in addition have made an appropriation for carrying on the cost work. The Clay Products branch and the Hollow Building Tile branch of the ceramic industry both expect in the near future to go ahead with a program of cost work. The Pottery Association also is giving a place to this work on the program of their annual convention and will doubtless make definite progress along these lines after that meeting.

Extensive study and research on specific phases of cost accounting has been carried on and the results have been made available to manufacturers in the following pamphlets: (1) What a "Cost System" Should Do for You, (2) Overhead Expenses—How to Distribute Them in Good and Bad Times, (3) Depreciation—Its Treatment in Production, (4) Perpetual Inventory or Stores Control, (5) Budgeting for Business Control.

It has also issued special bulletins and reports on other Cost Accounting subjects.

So far only the trade association aspect of Cost Accounting work has been covered but the Cost Bureau is pushing with equal emphasis the formation of Cost Councils within Chambers of Commerce to provide a meeting place where the cost accountants of the various Chamber members may meet and interchange ideas and policies. This effort has been ex-

tremely successful and there are now in existence some 15 such Cost Councils in active operation. In addition there are 25 other cities, spread from coast to coast and from the Gulf to the Great Lakes, which are displaying an active interest in this activity and in which at any time a Cost Council may be formed.

Standardization and Simplification

Intimately connected with cost accounting problems are those relating to standardization, simplification and the elimination of unnecessary variety. The Fabricated Production Department has conducted an investigation of some 350 commodity lines and has been responsible for accomplishments of wide-reaching effects. One of the most notable instances is in the paving brick line. At a conference held at the Department of Commerce, sponsored by the Fabricated Production Department, manufacturers, users and all interested parties discussed the 66 varieties of paving brick then being manufactured, and in a single day agreed on a reduction to 11 varieties. This was carried still further at a later conference and the number reduced to 7. The economies resulting are self-evident to all progressive manufacturers.

Other branches of the ceramic industry with which the department has been working on Standardization, and the present status of the work in those branches, are as follows:

Common Brick.—Common brick have been standardized as to size, there being only one size now produced. This was accomplished before the Fabricated Production Department engaged in Standardization activities.

Face Brick.—Size standardized and is identical with that of common brick. There seems to be little disposition on the part of manufacturers to in any way reduce the apparently wide variety of texture, color and style of face brick.

Sewer Pipe Clay.—The association representing the Eastern Manufacturers have their survey complete and data tabulated and are ready for a conference to adopt standards. The association representing the Middle Western Group, while interested in standardization, have as yet not compiled the information necessary to join in any conference looking towards national standardization.

Sanitary Pottery (Household).—In coöperation with the Bureau of Standards, standardization possibilities are being worked out. During the War, manufacturers of sanitary pottery made a 40% reduction in their varieties which curtailed list, it is understood, is still in operation.

Refractories.—Standardization accomplished by the Association, which has decided upon a fixed number of styles and shapes which they consider standard. All others are considered special orders.

Stoneware.—Through the efforts of the Fabricated Production Department, this branch of the industry has started an investigation in their many lines as to the possibilities for simplification and standardization. Considerable interest has been aroused, but no definite action as yet taken.

Interior Tile.—Standardization accomplished through the Association and varieties reduced from 735 to 115.

Hollow Building Tile.—Now making a survey, on the initiative of the Fabricated Production Department, and upon completion of this survey a simplification conference will be held.

There are probably many other branches of the ceramic industry where this question can be advantageously considered and a great deal of progress made if the parties most interested will get together and coöperate. The service and good offices of the Fabricated Production Department are available for this purpose at all times, to call a conference of all interested parties as in the paving brick case, or by any other means which may seem feasible.

Business Statistics

To determine the unprofitable lines of commodities produced, and for many other constructive uses, adequate business statistics are essential. Much of the trouble in our recent business depression could possibly have been avoided had there been available accurate information as to stocks on hand, quantity being produced, etc., in various commodity lines. False reports and figures led to a runaway market and later, when true facts became known and accumulated stocks were dumped on the market, it broke sharply and widespread business depression followed. The Fabricated Production Department is encouraging all lines of industry to make provision to gather as complete figures as possible on all statistical items vital to the industry.

In a recent survey, in which the department received replies from 246 associations, the returns showed that some 130 of these were now doing statistical work. The principal types of statistics now being gathered are as follows, the figure after each type representing the number of associations engaged in the collection of statistics on that particular subject:

Shipments	54	Production	47
Stocks on hand	34	Orders—new	31
Orders—unfilled	30	Sales	23
Wages and labor conditions	19	Orders—cancelled	11
Cost of doing business	10		

Many other types were mentioned, but the limitations of this article will not permit their inclusion.

The advantages of gathering adequate and reliable statistics have been

strongly phrased in the following manner by a leading trade association executive:

GOOD STATISTICS TELL A MANAGER

1. When to buy—when to sell.
2. When to hire—when to fire.
3. When to run—when to shut down.
4. When to distribute earnings—when to conserve cash.
5. When to stock—when to unload.
6. When to mark up—when to mark down.
7. When to borrow—when to pay.
8. When to expand—when to retrench.
9. When to push on—when to hold back.
10. When and how he can earn profits—when and how he must avoid losses.

Innumerable other advantages could also be cited.

Naturally enough the gathering of business statistics leads, to a greater or less degree, to the field of research work. Here again the Fabricated Production Department has been active in conducting a preliminary survey of those industries which are now carrying on this work and making the returns available in the form of a Bulletin to all interested parties. Many of the branches of the ceramic industry are now conducting extensive research work, and it is to be hoped that still others will realize the value of such work and arrange to engage in it in the near future.

General Problems

This article has only touched upon the high spots of the service of the Fabricated Production Department, but there are other production and manufacturing problems, too numerous in range and diversification to attempt to cover them in a brief article.

The department is in charge of Mr. E. W. McCullough, a man of wide experience, thoroughly familiar with manufacturing problems, who is assisted by a staff of experts in their respective lines. It is his desire to render efficient and practical service to manufacturers, and in furtherance of this desire the department keeps in touch with the work of the various divisions and bureaus of the Department of Commerce, Treasury Department, Federal Trade Commission, and other Governmental Agencies, working in the closest coöperation with all of them.

To all members of the ceramic industry, regardless of the branch to which they may belong, the Fabricated Production Department extends an invitation to make the fullest possible use of its service, with the assurance that such requests for assistance will meet with a most cordial response.

WASHINGTON, D. C.

CERAMIC INVESTIGATIONS AT THE MELLON INSTITUTE OF INDUSTRIAL RESEARCH

By Edward R. Weidlein[1]

The Mellon Institute of Industrial Research is a center for technical investigation in chemistry, chemical engineering, ceramics, and allied subjects. Its purpose is to promote industrial success through scientific research; in other words, to find new materials and new processes for industrial development, and to advance manufacturing through the application of scientific methods to industry. The Institute is a part of the University of Pittsburgh and enjoys close coöperative relationships with all schools of the parent institution.

Edward R. Weidlein

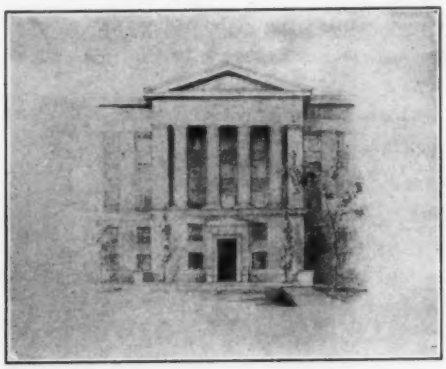
The working plan of the Institute is based upon the Industrial Fellowship System formulated by Dr. Robert Kennedy Duncan in 1906. This System, which was operated primarily in the University of Kansas, was inaugurated at the University of Pittsburgh in 1911. In 1913, Messrs. Andrew William Mellon, now Secretary of the Treasury, and Richard Beatty Mellon, a banker of Pittsburgh, established the Mellon Institute of Industrial Research on a permanent basis as a memorial to Judge Thomas Mellon, their father, and to Dr. Duncan. The continued financial support of the Messrs. Mellon has made it possible to develop the Industrial Fellowship System to its present strong position.

The System of Research

Before presenting a résumé of the research accomplishments of the Institute in the domain of ceramics, it is pertinent to describe briefly the operation of the Industrial Fellowship System. In accordance with this System, an individual industrialist, a company, or an association of manufacturers, having a suitable problem or group of problems requiring scientific investigation, may become the donor of an Industrial Fellowship, provided that the problems are of sufficient scope to warrant the services of at least one research chemist or engineer for a period of at least one year; and also that there is no other research in progress in the Institute

[1] Director of the Mellon Institute of Industrial Research of the University of Pittsburgh, Pittsburgh, Pa.

on the particular subject which is of interest to the prospective donor. The Industrial Fellowships of the Institute are of two general types: namely, Individual and Multiple. An Individual Industrial Fellowship utilizes the services of one research man (with assistants where necessary), who is responsible directly to the executive staff of the Institute. A Multiple Industrial Fellowship has the services of one or more Junior Fellows under the direction of a Senior Fellow, who, in turn, is responsible to the executive staff. As is well known, the Institute is not of a commercial nature, but is entirely independent, and derives no financial profit from the investigations conducted under its auspices.



The Mellon Institute of Industrial Research.

"This building is dedicated to the service of American industry and to young men who destine their life-work to the industries; the goal being ideal industry, which will give to all broader opportunities for purposeful lives."

The donor of an Industrial Fellowship provides a foundation sum which is adequate to cover the annual cost of maintenance of the investigation, which includes operating charges, the purchase of all necessary special apparatus or other equipment, and the salary of the research man or men selected to work on the particular problem, the solution of which is of concern to the donor. It is also essential that the donor extend coöperation by sympathetic encouragement and practical suggestion.

The Institute, in turn, provides laboratory, library, and consultative facilities, the use of its permanent research equipment, direction to the progress of the work, and an atmosphere which is conducive to productive investigation. All results obtained by the Industrial Fellowship belong exclusively to its donor.

The Industrial Fellowship System has been in successful operation at the University of Pittsburgh for 12 years, and it has been prominent in making clear to American manufacturers that scientific research, properly planned and systematically carried out under conditions favorable to productive effort, is remunerative to them and actually constitutes an investment. It is now recognized by industrialists that the methods of science are the most effective procedures thus far developed for the advancement of technology, and that, therefore, scientific investigation is an essential economic adjunct to manufacturing enterprises. But this understanding of the meaning and value of research has come in quite

recent years in the United States, for American manufacturers required demonstration of the economic value of scientific investigation. At

The staff of the Multiple Industrial Fellowship of the Refractories Manufacturers' Association. Left to right: W. R. Kerr, R. Ferguson, S. M. Phelps, and R. M. Howe (Senior Industrial Fellow).

present the encouragement of research and the recognition of the desirability of disseminating the knowledge gained are indeed among the most noteworthy signs of progress in technology.

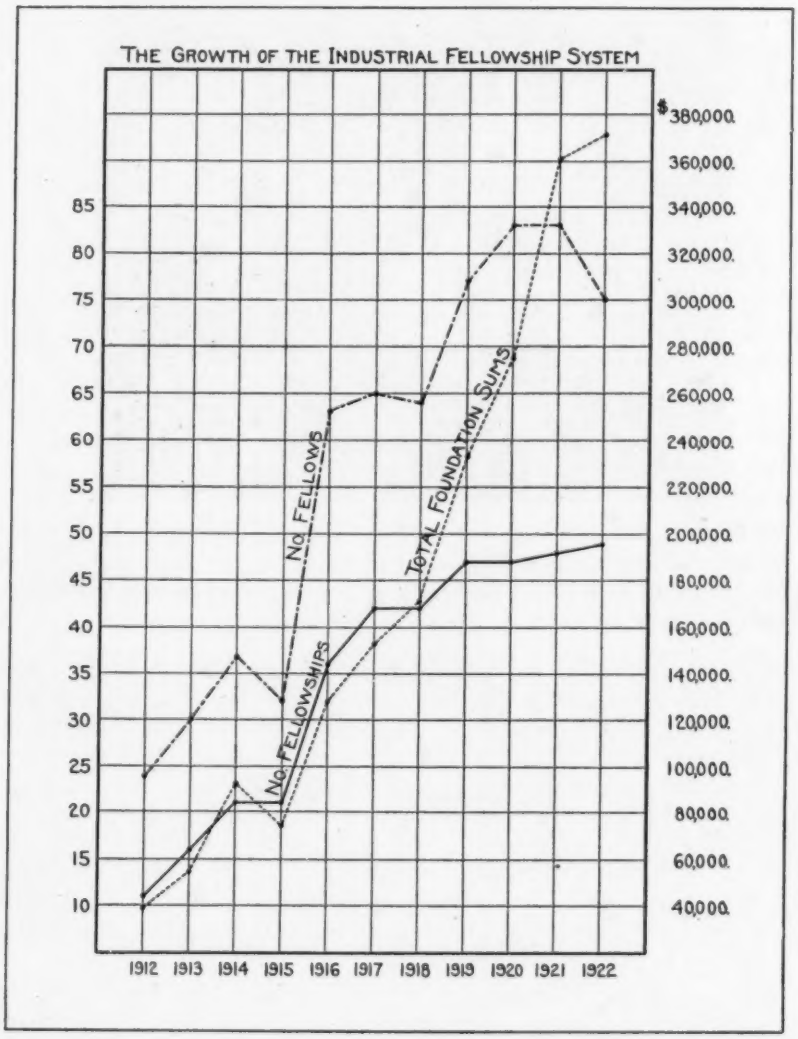
The Growth of the System

There are now (December 1, 1922) 50 Industrial Fellowships in operation and 85 research men are engaged thereon. The development of the System since 1912 is shown graphically in the accompanying figure. The number of Industrial Fellowships has grown from 11 to 50, while the total Fellowship receipts have increased tenfold.

The total amount of money contributed by industrial firms to the Institute for the eleven years ending March 1, 1922, was $1,955,922. During the same period, the Institute itself expended approximately $830,000. In addition to these sums, an amount of money now running into several million dollars has been spent by the industries in developing into large scale manufacture various processes worked out at the Institute.

There are now (December 1, 1922) 38 Individual and 12 Multiple Fellowships. The list of these investigations indicates the breadth and

diversity of the Institute's work. Since only one research is carried out on a particular subject at any one time, and since there is accordingly no duplication of the investigational activities of the Fellowships, there



is always a wide variety of different problems under study. Most of the Fellowships are well established in their fields of inquiry; and their renewal, year after year, attests to their research productivity and to the confidence which their donors have in the Institute.

Thirteen Industrial Fellowships have been founded by associations

of manufacturers. These Fellowships not only enable the Institute to be of direct service to groups of industrial concerns, instead of to individual companies, but their successful operation also gives rise to more stable relations of coöperation among the company-members of these associations by the induction of the reciprocal exchange of experience and research results. Four of the association Fellowships are in the field of ceramics.

The author has frequently been requested to give a statement concerning the financial gains which have been derived by donors as a result of the Institute's activities in their behalf. While he is not privileged to release this information at present, it may be mentioned that 85% of the problems accepted by the Institute, 1911–1923, have been solved satisfactorily from the donors' standpoints.

Researches in Ceramics

Dr. Robert Kennedy Duncan, the founder and first director of the Institute, was interested in the infusion of scientific method in glass technology and carried out several inquiries of technical importance in this branch of ceramics. Indeed, ever since its establishment the Institute has been active in research in the ceramic field. These investigations have included glass, enamels, dental cements, refractories, and other clay products. Dr. E. Ward Tillotson, Jr., an Assistant Director of the Institute and distinguished for his researches on the physical properties of glass, is in supervisory charge of the ceramic Fellowships of the Institute. Since it is recognized by the Institute that an industrial research establishment must be known by the successful commercial processes which it has developed and by the published accounts of the inquiries which it has carried out, the results of all ceramic studies are reported whenever possible in the *Journal of the American Ceramic Society*.

Experimental furnaces used in the systematic study of refractories and clay bricks, Mellon Institute of Industrial Research, University of Pittsburgh.

The first ceramic investigation undertaken by the Institute was a study of the cause of elimination of "strea" (striae) in fine glassware. As a result of this investigation, an improved glass pot was developed (U. S. patent No. 1,200,889, October 10, 1916, of Dr. S. R. Scholes) which has

proved to be of value for the heavy potash-lead glass employed in making fine tableware.

A second glass investigation, conducted by Dr. R. R. Shively, was devoted to translucent glass employed in lighting ware. Among the important developments of this inquiry was the production of a low-expansion translucent glass of superior heat-resisting properties and possessing unusual light transmitting and diffusing properties.

Studies of tank-furnace operation and control for the production of glass for automatic machines have been made by Dr. R. R. Shively and by Dr. J. F. W. Schulze.

Two investigations on enamels, one for sheet steel and the other on cast iron, are in operation at the present time. The sheet-steel Fellowship, of which Mr. R. D. Cooke is the incumbent, has been in operation since 1917. The published reports of his investigations are confined to two United States patents, Nos. 1,316,018, of September 16, 1919, on "Manufacture of Enameled Ware," and 1,272,917, of July 16, 1918, on "Removing Enamel from Enameled Metal Articles." Mr. J. E. Hansen is completing the third year of an investigation of enamels for cast iron.

Dr. C. C. Vogt, in an investigation of silicate dental cements extending over a period of three years, made discoveries which have enabled the production of an improved dental cement or "enamel." Dr. Vogt has presented certain of his results in a paper entitled "The Chemistry of Silicates and Their Application in Dentistry."[1]

H. G. SCHURECHT

Since 1915 there has been in progress an investigation on refractories supported by the Refractories Manufacturers' Association. Reports on several specific problems have been published by Mr. R. M. Howe, Senior Incumbent of this Industrial Fellowship, and by his co-workers. In addition to many improvements in the manufacture of refractories, Mr. Howe has accomplished much in coöperation with the A. S. T. M. in standardizing the testing of refractories. During the period of 1919 to 1921, Mr. Mark Sheppard carried out successfully a study of the manufacture of zirconia refractories. While a complete report of his findings has not yet been published, the commercializing of them is dependent only upon economic conditions.

[1] *Journal of the National Dental Association*, **5**, 354–73 (1918).

Mr. H. G. Schurecht has lately commenced an exhaustive study of vitrified clay products under the auspices of a large group of manufacturers of sewer pipe and drain tile. The program of this investigation is an ambitious one and involves the study of fundamental problems as well as problems in technology.

This, in brief, is what the Mellon Institute has done and is doing in research in ceramics, a branch of technology in which the Institution is vitally interested, not only because of its location in a district which has a dominant position in the manufacture of glass, face brick, refractories, and similar ceramic products, but principally because of the essentiality of effecting advances to keep pace with the requirements of users of ceramic products. Until comparatively recent years progress in ceramic technology had been with a halting step, but that period has passed and now all important branches of the great ceramic industries are cognizant of the high technical value of scientific research carried out for their benefit.

MELLON INSTITUTE OF INDUSTRIAL RESEARCH
UNIVERSITY OF PITTSBURGH
PITTSBURGH, PENNSYLVANIA

THE PITTSBURGH TESTING LABORATORY IN THE CERAMIC FIELD

BY JAS. O. HANDY

A research and testing institution such as the Pittsburgh Testing Laboratory, established in 1881 in a district already a center of the glass, pottery, enameling, cement and clay-working industries, naturally has given special attention to the problems of these various branches of the ceramic industries.

JAMES OTIS HANDY

In the field of glass manufacture investigations have been conducted for the makers of plate glass, window glass, illuminating glassware, table glassware, and optical glass. Defects such as stones, seeds, discoloration, seams, strains, etc., have been traced to their sources in the use of improper or too coarse materials, improper temperature control, insufficient gas evolution at the proper time during melting, and improper annealing technique.

Batch formulas have been revised and in many cases it has been found possible to make better glass at less cost than at the beginning of the investigation. We have found it quite customary to use excessive amounts

of expensive materials in the batch without real benefit and even with actual damage to the quality of the glass. Close studies of apparatus used for sand grading in plate glass manufacture and for the machine blowing of window glass have been made.

In the illuminating glassware industry the Laboratory has been closely associated with the development of the so-called "semi-translucent" glass which permits the passage of a large percentage of the light from the electric filament without the phenomenon common to opal glass and known as "fire."

In the field of enameling cast iron and steel the Laboratory has been called upon to investigate troubles caused by crazing, chipping, etc., and

to prepare less expensive enamels while still maintaining high quality. This work has been quite successful, particularly in the cast iron enameling industry.

Enamels are exceedingly complicated mixtures of silicates, borates, and fluorides, and the maintenance of uniformly good quality requires close attention. Many of the large articles which are enameled vary greatly in thickness and shape so that the production of an even and highly lustrous coating of enamel over such varying surfaces is a real art.

In the manufacture of basic refractory materials the Laboratory has assisted in the development of granular coated dolomite which during the

war emergency successfully replaced the imported granular magnesite for use in the construction of basic open hearth furnace bottoms. This material is made in rotary kilns, and while the process as developed is a very simple one, it required a great deal of experimental work before it was perfected. Properly made, granular coated dolomite resists the action of atmospheric moisture for long periods of time so that it may be kept in storage for a considerable time before it is used. Finally, its coating of basic slags assists in the binding together of the granular materials in the furnace bottom, and makes a more permanent bottom and one which can be prepared in a shorter time than one made from magnesite.

In the hydrated lime industry it is sometimes a problem to make from certain limestones or dolomites a hydrated lime which has the required degree of plasticity or spreading qualities. The experiments have succeeded in making such hydrated lime from raw materials not normally yielding the desired product.

In the gypsum products industry the manufacture of Keene's cement was the subject of investigation. Magnesium oxychloride or Sorel cement products have been made and tested.

Portland cement concrete failures have been the subject of many investigations.

For the convenience of the ceramic industries we maintain in Pittsburgh laboratories equipped with facilities for testing ceramic materials both in the raw and finished states, and by both chemical and physical methods.

Gas and electric furnaces for making vitrification and fusion determinations and load tests are available, and there are facilities for burning experimental lots of clay or shale and limestone intended for cement manufacture.

Limestone, dolomite, magnesite, fire clay, feldspar, fluorspar, silica rock, gypsum, Portland cement, etc., are all being tested in different ways and at frequent intervals.

The personnel of our chemical department is as follows: J. O. Handy, Director of Special Investigations, H. H. Craver, Manager of the Chemical Department, C. E. Betz, Chief Chemist, and a corps of assistants.

PITTSBURGH, PA.

FOREIGN CERAMIC SOCIETIES

England, Germany and Japan have Ceramic Societies which have the same scope and purposes as has the AMERICAN CERAMIC SOCIETY. Nearly every manufacturing country has technical societies and journals devoted to particular industrial ceramics and also national commissioners and surveys which make ceramic investigations. The British Government probably has done more to encourage industrial research by organized groups than any other country. It is safe to say there is no ceramic group of commercial importance in any country that does not have a federation of ceramic manufacturers engaged in technical and scientific research.

It was the aim of this review to have a sketch of the organized research activities, of the press and of the schools devoted to ceramics in each of the foreign lands. That there are omissions in the account here given is due neither to want of effort to secure this information nor to the desire on the part of fellow craftsmen in other lands. Shortness of time was the defeating factor.

THE CERAMIC SOCIETY

BY JAMES A. AUDLEY

In attempting to trace the progress made in ceramics in the British Islands during the past twenty-five years or so, it may at once be stated that for a long period before the commencement of the present century very little had been done in the way of systematic research. Indeed no facilities for such research had existed either in educational insititutions or factories since Wedgwood's time.

The first regular course of lectures bearing on ceramics appears to have been delivered at the Potteries Mechanics' Institution, Hanley, by the late Dr. Thomas Carnelley (afterwards Professor of Chemistry, first at Dundee and later at Aberdeen), who travelled specially from the Owens College, Manchester, to give one lecture every other week. This was in the late seventies, the course of lectures being on "The Chemistry of Pottery." It was not until the autumn of 1884 that the first regular class in "Pottery and Porcelain Manufacture" was started in the district, at the same Institution in Hanley, by the late Mr. Miles Knowles, Head Master of the Tunstall Endowed School, who, as Science Master at Hanley, had previously conducted evening classes in science. A year later a similar class was established at the Wedgwood Institute, Burslem, by the late Mr. S. J. Harris, who soon afterwards, with the aid of Mr. H. Watkin, arranged a simple course of practical exercises to supplement the lectures. The practical work greatly promoted the success of the classes, but there was still nothing that could be styled systematic research. In 1890 (when Mr. Harris left the district) Mr. Watkin took sole charge, but later he had

for several years the assistance of Mr. H. E. Wood, now (1922–23) president of the Ceramic Society. In 1899 the late Mr. W. Jackson was appointed instructor of the pottery classes, which for convenience were transferred from Burslem to the Victoria Institute, Tunstall, where a laboratory was specially equipped for practical work in pottery and porcelain manufacture. Mr. Jackson resigned towards the end of 1904 and accepted an appointment with a local firm of manufacturers. Early in 1905, Dr. J. W. Mellor was appointed to fill the vacancy and carried on the good work. Near the end of 1908 a large temporary structure of iron and wood was erected near Stoke Railway Station to accommodate the pottery classes which were transferred from Tunstall. Here great progress was made until 1913 when the pottery department in charge of Dr. Mellor was more worthily housed in a commodious permanent building close by in which were combined exceptionally good facilities for both teaching and research. Thus in baldest outline is indicated the course of development of facilities for ceramic educational and research work in North Staffordshire which may be regarded fairly as the ceramic center of the kingdom.

It has been mentioned that Mr. Jackson took charge of the pottery classes in 1899, with the advantage (over his predecessors) of a specially fitted laboratory for practical work. A natural consequence of this was that it soon became possible for some of their more advanced students to apply their knowledge and experience by carrying out investigations under Mr. Jackson's guidance. Moreover, the informal discussions of their problems at the school led to the suggestion of holding periodical meetings for dealing more fully and systematically with various questions of interest as they arose. In this way originated "The North Staffordshire Ceramic Society" which appears to have commenced in 1901 with Headquarters at the Victoria Institute, Tunstall. In 1903, the name was changed to "The English Ceramic Society" and in 1916, it was again changed to "The Ceramic Society" so as not to conceal the cosmopolitan character of its membership. The Headquarters of the Society passed over to Stoke along with the chief pottery school.

From what has been stated it seems clear that Mr. Jackson may properly be called the founder of "The Ceramic Society." Mr. F. Hodgkinson was Secretary for the first year and was succeeded by Mr. Jackson who continued to hold that office until 1905 when he was elected President. Mr. Jackson was for some years a regular contributor to the *Transactions* but with diminishing frequency after 1909. After leaving the Tunstall Pottery School Mr. Jackson's services were secured by the late Mr. Alfred Meakin for his factory at Tunstall. On Mr. Meakin's decease a few years later Mr. Jackson went to Minton Hollins and Co.'s Patent Tile Works at Stoke. Ill health afterwards compelled him to retire from pottery work. His health being restored he took up Government work during the War

at Hadfield (Lancashire) as a superintending technical chemist, being engaged in the purification and preparation of cotton for use in making cordite and other war munitions. He also conducted classes in chemistry at Rossendale and other places. When the War ended Mr. Jackson acquired a glass and china business at Bury. He was associated with Mr. J. P. Holdcroft in the invention of the thermoscope so much used in connection with the firing of pottery. In early years Mr. Jackson won a Scholarship at the London Royal College of Science and afterwards gained a Scholarship at Zurich University. On returning to England he became Science Master at the Victoria Institute, Tunstall. He died on January 10, 1921 at Stacksteads near Manchester.

Of those who were associated with Mr. Jackson in the inauguration of the Ceramic Society, mention has already been made of Mr. H. Watkin and the President (Mr. H. D. Wood) both of whom have figured in the list of contributors. Mr. Watkin is identified with the firm of James Macintyre & Co. Ltd., Burslem, and is well known for the heat recorders which bear his name. Mr. Wood has had a long and honorable connection with the Burslem Pottery of Messrs. Doultons, Ltd., and has maintained a keen interest in the Society all along. In the first volume of *Transactions* appears a paper by him on "Bone in English China." Other contributors to this volume were the late Mr. W. P. Rix, Mr. Arthur Lovatt, and Mr. R. H. H. Jones. The last named was treasurer from the start until 1916 when he left Staffordshire to take up the management of a works in Devonshire. In the first volume also appeared some abstracts made by Mr. Jackson from several German periodicals.

The first president was Mr. William Burton, widely known for his valuable books on pottery subjects and formerly managing director of Messrs. Pilkington's Tile and Pottery Works at Clifton Junction near Manchester. He was succeeded as president by Mr. Bernard Moore well known as an accomplished practical potter and by his valuable contributions to the *Transactions*. Next followed Mr. J. P. Holdcroft formerly a pottery manufacturer but for many years past a brick maker and manufacturer of the familiar Holdcroft thermoscopes and then Mr. Abraham Fielding a well known pottery manufacturer at Stoke. Then came in turn the late Mr. W. Jackson, the late Mr. F. Rawdon Smith and the late Mr. L. Solon the latter being the world famous pottery artist who accumulated a fine collection of books and pottery and whose sons occupy important positions in the ceramic world.

Returning to the consideration of the earliest members, other noteworthy names are those of Messrs. Asaph Leese, A. G. Richardson and F. Turner. The two latter not only contributed to the *Transactions* from time to time but for a number of years they rendered valuable assistance as teachers in the local pottery classes. Mr. Leese who has been throughout one of

the most regular attenders has also been a contributor of papers at various times and was elected President in 1916. Another original member who has contributed freely and retains keen interest in the Society is Mr. Arthur Heath whose capacity for organization has often proved of great value to the Society in connection with excursions, etc. He is personally known to many members of the AMERICAN CERAMIC SOCIETY.

Turning now to later years it needs no demonstration that under the direction of Dr. Mellor as secretary of the Society and as Head of the Pottery School at Stoke (as well as in other capacities) the increased facilities have resulted in an enormously expanded output in the shape of results of investigations in almost every department of pottery work. A constantly growing band of capable well-trained students and assistants are ever resolutely attacking problems new and old in a systematic way under the direction of their chief and in this way is being accumulated a vast store of information and valuable data for the use of all who know how to apply such knowledge to practical advantage.

As previously noted a few abstracts from foreign journals appeared in he very first volume of the *Transactions*. Unfortunately no more are to be found until Volume VI is reached, but here they were taken up at Dr. Mellor's instigation on a much more extensive scale, the sources being various German, French, American and British journals. Henceforth with the exception of Volumes VI and XV abstracts were published in every volume issued. For some years the abstracts represented the voluntary work of a number of members. Then for several years they were prepared by the International Institute of Technical Bibliography. In 1917, it was decided to engage a part time abstractor to prepare the abstracts and finally, in 1920, a full time abstractor was engaged.

In 1916, the Governors of the Central School of Science and Technology at Stoke acquired the late Mr. L. Solon's ceramic library reputed to be at the time the finest and most nearly complete collection of ceramic publications in existence. It includes many rare items and is housed in the same room as the Ceramic Society's library.

It is of interest to note that eight meetings of the Society were held in the first year with an average attendance of fifteen out of a total membership of thirty. In the second year there were nine meetings and fifty-four members with average attendance of twenty-two. Nine meetings were also held in the third year, the membership being sixty-eight and the average attendance 23.5.

A very important development took place in December, 1916, when the Refractory Materials Section of the Society was established. This was not instituted too soon for before the War nearly all the magnesite bricks for basic steel furnaces and other purposes came from Austria and new sources of supply had to be found quickly. Moreover, various other re-

fractories were needed in increasing quantities and the aggregate output had to be greatly expanded. Part of this increased output was needed to send to neutral countries in exchange for essential materials and part for allies. The Society had not altogether neglected the subject of refractories previously for papers bearing on some aspects of the subject had appeared from time to time in the *Transactions* but very little organized research work in this direction had been undertaken, there being practically no funds available for the purpose. Nevertheless, a certain amount had been taken up at Stoke by Dr. Mellor and his assistants and at Leeds University by Professor J. W. Cobb and his co-workers. Both of the gentlemen just mentioned have continued to direct important researches on various materials, old and new. This development brought a large number of new members to the Society but the Refractory Materials Section has maintained a semi-independent organization with its own Council though the same Secretary and Treasurer have always acted for both the parent Society and its vigorous offspring. Another striking consequence was a great widening of the field for abstracts.

Among the outstanding figures connected with the Refractory Materials Section besides those already named may be mentioned Sir William J. Jones, formerly of the war-time Ministry of Munitions, and Lieut.-Col. C. W. Thomas of Stourbridge each of whom has occupied the presidential chair.

Another development of somewhat later date perhaps deserves more than a passing mention. The art side of ceramics only cropped up incidentally on very few occasions. The first systematic attempt to discuss this aspect of the subject was by Mr. J. Eyre in March, 1917, his paper being entitled "On the Necessity of Science and Art in Modern Pottery Manufacture." It appeared in Volume XVI of the *Transactions* (1916–17). In January 1918, Mr. A. E. Gray read a paper on "The Encouragement of Art in the Potteries" which is printed in Volume XVII of the *Transactions* (1917–18). This led in a very short time to the establishment of an Art Section with its own officers and council. This Art Section has done considerable propaganda work by means of lectures and discussions, exhibitions of paintings and other works of art, exhibitions of modern pottery, etc.

Thanks to the results attained in very large measure through the activities of the Ceramic Society and its Refractory Materials and Art Sections, there can be no doubt that the ceramic industry now rests on a much firmer basis than it did twenty years ago. Much of the old-time mutual distrust and suspicion among manufacturers has gone and there is a wide-spread desire to promote systematic investigation by competent observers. The continued existence of such an atmosphere would be the best security for further progress. The Ceramic Society should be in future, as in the past, a radiating center for such progress.

THE SOCIETY OF GLASS TECHNOLOGY

By W. E. S. Turner

During the summer of 1916, the students attending the various local center courses in Yorkshire conducted by the Department of Glass Technology, University of Sheffield, had two or three pleasant joint meetings when, after a visit to some works and subsequent social intercourse, more or less informal discussions were held on some problem connected with glassmaking. It seemed to the writer that these meetings might well be put on a more permanent basis.

There existed no scientific society which made any appeal to the average glass manufacturer and it was felt that to have such appeal, any society formed must deal with the subjects near his heart and concentrate on them. Not only was there no scientific society but there was no organization at all which brought together all persons interested in the industry. It was, indeed, discovered during the early meetings of the Society that many well-known manufacturers had never met one another although known by name to each other for years. Under such conditions it was not surprizing that a meeting called at the University of Sheffield in October, 1916, received the idea of a society very favorably and after necessary preliminaries the Society of Glass Technology came into existence at a meeting on November 9, 1916.

The new Society arrived at an opportune moment and enthusiasm ran high. Membership was not made exclusive, the main condition being a desire to promote the advance of scientific study connected with glassmaking. In the words of the Society's Constitution, the objects were: (*a*) The association of persons interested in glass technology. (*b*) The general advancement of the study, science, and general practice of glass technology.

Three classes of members were recognized, namely, (1) collective, (2) ordinary and (3) student members. More recently, a class of honorary members has been established. The following figures of membership show the growth of the Society:

1916–17	264
1918	391
1919	516
1920	620
1921	663

Of the 663 members on the roll at the end of 1921, 142 were collective and 516 ordinary members.

Although the headquarters of the Society were established at Sheffield, the University authorities kindly offering accommodation, it was believed to be in the general interest that the monthly meetings should be held

at different centers of the industry in order to stimulate local interest. Further, in order to emphasize the national character of the work, despite its origin in Yorkshire, the officers of the Society were deliberately chosen so as to give as wide a representation as possible to the different glassmaking centers.

Under the influence of the Society, a change took place in the mental outlook of the industry. The country was at that time united in a common purpose to win the War. There was, therefore, a disposition towards coöperation which naturally grew as competition from abroad grew less and less and internal competition grew slack in the face of the heavy demands on the industry. But if there were these influences in favor of discarding the intense secrecy, long a tradition in the industry, it was the work of the Society which, by the establishment of cordial relationships and even personal friendships among members of the industry, made possible an exchange of information and willingness to give as well as to take. One result was soon seen in the way in which manufacturers consented to admit parties of members of the Society to their works without limitation. The spirit thus born has continued to live. In times of severe trade depression like the present there may be less inclination to admit into works possible competitors, but the writer believes the industry will never again go back to its ruts and its troughs, cherishing secrets which are not worth cherishing.

The publication, which began in May 1917, of the *Journal of the Society*, soon began to make the Society's work known outside the United Kingdom and the Society had the pleasure of welcoming applications from overseas, and particularly from friends in the States. Out of the membership of 663 registered at the end of 1921, 169 were resident outside Great Britain and Ireland. The proportion of overseas members is bound to grow as time proceeds and the Council trusts that these overseas members will not merely take, but will begin also to contribute, by papers and discussion, to the Society in which they enjoy membership.

Up to the present time, the Society's activities have been largely devoted to the dissemination of knowledge through the reading and publication of papers and by the educating influences of mutual knowledge among the glass manufacturers. The Society's subscriptions are so small that no funds have as yet been available for subsidizing researches; but there is no doubt that the influence of the Society's work has greatly strengthened existing research institutions and made possible also the founding of the Glass Research Association; while there is equally no doubt that the Department of Glass Technology in the University of Sheffield has stepped in time after time, when other papers for discussion have not been forthcoming, to furnish the results of researches and create topics for discussion.

Undoubtedly, as the Society gains in strength financially, its support of researches will become an important element in its work. In 1918, the British Ministry of Munitions, realizing the urgent need of improving glasshouse refractory materials, entrusted the Society with a grant of £1000 and told it to go ahead. The result was the issue of the Provisional Specifications for Glass Refractories, while the Department at Sheffield was subsidized to carry out extensive researches, now published, on fire clays.

The Society has committees of an advisory character, namely, the Refractory Materials Research and Specifications Committee, and a committee on Glass Standards. It also coöperates with other bodies having like interests. The Society is preparing a Directory for the British Glass Industry. This does not strike one as connected with scientific research but it is work that has long required to be done and this is the one reason which has impelled the Society to undertake it.

In view of the special occasion for which this article is written, it would not be paying an acknowledgment we feel due, if the writer did not say how much our own glass industry and our own Society has been stimulated and influenced for good by progress in America and by the work of the AMERICAN CERAMIC SOCIETY. Our members will never forget their visit of 1920 and other members who have paid individual visits have told the writer how impressed they have been both by the kindness shown to them and the education in new methods they have received in America. Friends in America have, on the other hand, told the writer at times of the respect they have for the work of our own Society. May this mutual respect, founded on the belief that we are both doing our best for the advancement of silicate technology and endeavoring honestly to be of service to our fellows, grow more and more during the next five and twenty years.

THE UNIVERSITY OF SHEFFIELD, ENGLAND

TEACHING AND RESEARCH IN GLASS TECHNOLOGY AT THE DEPARTMENT OF GLASS TECHNOLOGY, UNIVERSITY OF SHEFFIELD

BY W. E. S. TURNER

Among the many deficiencies revealed by the War was the absence of any provision in Great Britain for instruction or research in the subjects comprised under the general heading of Glass Technology. True it was that for some years the City and Guilds of London had issued the syllabus of a scheme of instruction and at one center, namely, Wordsley, under Mr. Stourbridge, a class had been run at the local technical school, being attended, however, more frequently by the glass decorators than by the glasshouse workers.

A survey made early in 1915 by the writer showed clearly how sadly neglected the industry had been by organized scientific bodies and how very deficient, on the other hand, were the glass manufacturers themselves even in the rudiments of scientific knowledge. It was also found that almost on the doorstep of the University at Sheffield there was a large and important glass industry, namely, that of the West Riding of Yorkshire. So strong a case was made out for assisting the industry that the duty of the University seemed clear and the Council had little hesitation in deciding to found the Department of Glass Technology for the express purpose of providing courses of instruction and facilities for research. Mr. H. A. L. Fisher, then Vice-Chancellor of the University and later Minister for Education in the Government, was a very strong supporter of the scheme. The writer was invited to take in hand the organization of the Department.

The Department was not content to wait for students to come to it. It had a mission for those in the industry who could not come; and local center courses, providing very elementary courses for the workers, were established in several centers of the industry in Yorkshire and attracted numerous students varying in age from 18 to 60. The courses were progressive, a complete course lasting three or four years; moreover, as the news spread of what was being done in Yorkshire, other centers were started in other areas, and classes of this type have been held in Derby, London, Alloa, Glasgow and Newcastle, in addition to the Yorkshire centers (Barnsley, Castleford, Knottingley, Leeds, Mexborough, Morley, Sheffield and York).

At the University itself, a three years' Diploma course was at first set up; but it was soon found that the subject of Glass Technology must be accorded full recognition in the University curriculum and in 1918 it was made a full degree subject, while further, in 1920, an Honors School was established. The courses are open to all students, whatever their country or origin; and, indeed, students have come from many parts of the world. Postgraduate students are especially welcomed and the research facilities enabling graduates of British and foreign Universities to work for the degree of Ph.D. are ample.

While the initial expenses of the Department and much of the later expense have been borne by the University direct, several bodies have made contributions. In 1915 a Committee of the Privy Council of the Government was set up for the express purpose of fostering industrial research, and from that body a capital grant for equipment of £1,500 was obtained, together with an annual grant for five years of £1,200. The capital grant was made conditional on the glass manufacturers themselves also subscribing; and grants from the Yorkshire Glass Bottle Manufacturers' Association, the Yorkshire Flint Glass Manufacturers' Association, and

later also, the Association of Glass Bottle Manufacturers' of Great Britain and Ireland, each of £1,000, made it possible to erect a small building on a site purchased by the University. This building contained a lofty glass melting room 55 ft. x 35 ft. with other rooms for storing and mixing batch, pots, and machinery, and a lampworking room. In 1917, the Ministry of Munitions, Optical Munitions branch, provided a further £3,000 for equipment, in view of the Department doing special work for the Ministry.

A big expansion of premises was decided on in 1920. For some time, the growing activities of the Department had found the original premises becoming too small and it was decided to expand if the necessary funds could be raised. In 1920 it was also decided to undertake certain melting work for the newly-formed Glass Research Association. Sufficiently adequate facilities did not exist to carry out the operations on the large scale required and immediate expansion of the existing premises being then beset by difficulty, an offer of sale of a local glass works was taken advantage of. Towards the purchase of the works, glass manufacturers subscribed about £7,000 while the University showed its friendship to the industry by furnishing several thousands more for completing the purchase and for commencing to equip the premises. The severe trade depression which began at the end of 1920 prevented the scheme of equipment from being more than partially realized. The buildings, however, which, after modification, comprize a set of laboratories, large pot rooms and mixing rooms, two glasshouses and auxiliary buildings, are sufficiently large as to give ample room for further development when funds are available. The glass melting facilities are extensive and make it possible to produce glass in quantities varying from the thimble full to a 1000 lbs. For the last-named, there is a two-pot recuperative furnace fired by producer gas. In small quantities, the meltings are carried out by town gas or by electric heating.

In addition to the teaching activities already mentioned, there are three others which must be outlined. The first was the setting up in 1917 of a Lampworking School to train bench glassblowers for an industry which practically had to be created after War broke out. Boys, girls, and disabled soldiers were trained for this work, 92 in all receiving courses of training and practically all of them being placed in situations. Inventions to burners, in semi-automatic lampworking machines, and in graduating apparatus were also made. Owing to trade depression and lack of funds the School had definitely to be closed in July, 1922.

Next, the Department has long served as a center where manufacturers can bring their troubles, and scarcely a day passes without one or more inquiries for assistance in some form or other coming in. Tests, varying from the examination of raw materials to investigations involving numerous

meltings of glass are regularly made for manufacturers privately who bear the cost. Investigations of wide scope are at present also carried out for the Glass Research Association.

Finally, fundamental researches in glass technology are recognized as one of the main objects for the existence of the Department and between 1917 and the date of writing (October, 1922) 68 papers and reports embodying research on a great variety of subjects have been published, in addition to those which pass direct into the hands of the Glass Research Association and are published in the Bulletin of that Association. The members of the staff of the Department also are mainly responsible for preparing the abstracts of papers which appear in the *Journal of the Society of Glass Technology*.

Over the interests of the Department there presides a body called the Glass Research Delegacy. It is constituted in approximately equal numbers of University representatives and the nominees of glass manufacturers' associations and other interested bodies. The Chairman is Sir Albert Hobson, J.P., LL.D.; Vice-Chairman, Mr. Frank Wood, C.B.E., B.Sc.; and Secretary, Mr. W. M. Gibbons, M.A. (who is also the Registrar of the University). The funds for maintaining the Department come from a variety of sources: from the University Council, the West Riding of Yorkshire County Council, manufacturers' associations, students' fees and donations. Quite a large proportion of the income is derived from work done both for the Glass Research Association and for individual manufacturers.

THE UNIVERSITY OF SHEFFIELD, ENGLAND

INSTITUTE OF CHEMISTRY GLASS RESEARCH COMMITTEE, 1914–1922

BY RICHARD G. PILCHER

At the outbreak of War, meetings of chemists were held under the auspices of the Institute to consider the steps to be taken to insure a continued supply of chemical glass and porcelain apparatus, filter papers, and analytical reagents which had previously been almost exclusively obtained from abroad.

An Advisory Committee of the Institute was appointed to supervise research on glass at the expense of the Institute with a view to arriving at suitable formulas to be available to manufacturers who were willing to assist in maintaining the supply of glass apparatus.

The first formula was produced mainly as the result of experiments of Sir Herbert Jackson and Dr. T. R. Merton on November 30th, 1914, for an alumina-soda glass suitable for the manufacture of chemical labora-

tory ware. This was sent to firms likely to be interested in the industry.

Varieties of foreign glass were analyzed, and the Committee received further formulas from Professor Jackson, as the main worker under the scheme, of substitutes for Jena glass, and, in addition, a formula for the manufacture of miners' lamp glasses of which a very large number, probably two millions, are used annually in this country. At the same time, independent workers including Messrs. Baird and Tatlock, London, Professor H. B. Baker, and Mr. F. W. Branson devised formulas for batch mixtures which were used by manufacturers.

The work of the Glass Research Committee of the Institute continued practically throughout the War. As it progressed, the expenses involved became considerable and the Institute obtained substantial financial assistance from the Department of Scientific and Industrial Research before eventually the work was merged almost entirely under the Ministry of Munitions.

In April, 1915, eleven formulas for various purposes were sent to manufacturers and published in the scientific and technical press with the result that they were even reproduced in Germany. From that time, however, the British manufacturers made good progress with the production of laboratory glass as well as with miners' lamp glasses, glass for X-ray tubes and for other purposes. Other formulas were published by the Institute from time to time until the glass production came under the control of the Ministry of Munitions, after which the formulas were reserved for the use of selected manufacturers. Altogether more than 70 formulas for batch mixtures, including varieties for optical and other purposes, were produced by Sir Herbert Jackson. They included glass suitable for electric light bulbs, opal glass, thermometer glasses, glasses for the manufacture of artificial human eyes, resistant lamp chimneys, milk bottles, vessels for preserving food; and enamels for sealing different kinds of metallic wire into glass, and soft black glass for filling in the caps of incandescent electric lamps.

The work was continued under the joint auspices of the Ministry of Munitions and the Glass Research Committee of the Institute of Chemistry until practically the date of the Armistice, since when the Committee has become merged in a Special Purposes Committee of the Institute which deals with matters affecting the laboratory requirements generally of chemists.

30 Russell Square
London, W. C. I.

GLASS RESEARCH ASSOCIATION

By Edward Quine

The Glass Research Association was established to investigate into the problems of the glass industry in accordance with the scheme of the Committee of the Privy Council for Scientific and Industrial Research.[1] The Association received its Certificate of Incorporation on August 11, 1919, and held the first general meeting on October 14th following.

The objects of the Association are to conduct scientific and technical investigations relating to glass and its manufacture, and to disseminate among members technical and other information bearing on these subjects and on the production of articles made wholly or partly of glass.

In order that the industry may attain a high degree of efficiency, it is necessary for investigations to be directed towards overcoming difficulties, in the matter of technique, works organization, production and equipment, in addition to investigations of fundamental principles and search for new knowledge. To ensure greater economy in production and more satisfactory products, improved methods must be introduced, and the works practice of the industry brought into line with the advanced methods found operative in other countries. Until recent years no comprehensive research work relating to the industry had been carried out in this country, but the need for a deeper and more extensive knowledge of the fundamental facts underlying the various processes of manufacture is now appreciated. The Association is consequently endeavoring to investigate the fundamental principles and their application by systematically conducted researches, so that, side by side with the modernizing of works practice, and the introduction into the industry of the scientific control of the various operations, new knowledge may be developed to the point of plant application.

Edward Quine, Secretary, Glass Research Association.

The investigations of the Association cover the problems of all sections of the glass industry other than those of optical glass research work which is being undertaken by the British Scientific Instrument Research Association.

The membership of the Association is limited to British corporations and British subjects carrying on business in connection with the manu-

[1] *Bull. Amer. Ceram. Soc.*, **1** [11], 326(1922).

facture of glass, and other trades and industries allied therewith or accessary thereto. Individuals ineligible for membership or not desiring admission as members, who are interested in the glass industry and willing to subscribe to the objects of the Association, may be admitted by the Council as associates.

ROBERT L. FRINK

The management of the Association is vested in the Council with an Executive Committee; the Council consists of a majority of elected members together with a limited number of members co-opted because of their special knowledge and experience, and members nominated by the Department of Scientific and Industrial Research. The Chairman of the Council is Mr. George E. Alexander, O.B.E., whose invaluable support and direction have been largely responsible for the successful establishment and progress of the Association.

GEORGE E. ALEXANDER, O.B.E., Chairman Glass Research Association.

The organization and direction of research work is entrusted to a Director of Research, and the Association appointed to this post Mr. R. L. Frink, formerly of the Frink Laboratories, an active member of long standing of the AMERICAN CERAMIC SOCIETY, who took office on the 1st of March, 1920.

The Director of Research works in close consultation with seven research committees, has been appointed by the Council to survey the field of research in relation to glass and the glass industry. The terms of reference of these committees are:

1. Chemical and physical properties of glass. (At all temperatures.)
2. Fuels, refractories, furnaces.
3. Glass-making materials, glass-founding, temperature measurement and control; annealing and finishing other than decorative and marking operations.
4. Glassware-forming operations—hand and mechanical; glassware-making machinery.
5. Lamp-working.
6. Design, layout, and equipment of glass factories.
7. Glass decorative and marking operations.

The program of research covers a wide range of subjects, including investigations into the following problems:

1. The dependence of fusibility, range of viscosity, color transparency, brilliancy, refractivity, heat conductivity, expansibility, electrical conductivity, tensile and crushing strength, hardness, brittleness, elasticity, working properties in the blow-pipe flame, resistance to chemical action, and devitrification upon the chemical composition of the glass.

2. The examination and treatment of clays and bricks, the composition and methods of manufacture of refractory materials, the firing of pots, and investigations in regard to refractory materials.

3. The design, construction and operation of furnaces, tanks, pot arches, leers, kilns, glory-holes, etc.

4. The relative value and efficiency of coal, coke, oils, tar, and other combustible mixtures, and gas-producers for various types of furnaces and leers, and the investigation of electrical methods of heating.

5. The most suitable raw materials by means of which to introduce certain chemical elements in the best and most economical forms.

6. Methods of batch mixing.

7. Measurement and control of temperature during founding, chemical and physical changes during founding, determination of most rates of charging and founding different types of glass, effect of furnace gases upon the various types of glass during founding; methods of aiding the fining process.

8. Examination and improvement of the methods and conditions under which molten glass can be conveyed to the forming apparatus; molds and their treatment; mechanical processes of forming glass.

9. Investigation of annealing temperatures, rates of annealing, effect of annealing on physical and chemical properties; methods of detecting and measuring strain.

10. Cracking-off, grinding, etching, enameling, decorating, graduating and marking, lamp-working machinery, and other mechanical processes of finishing.

11. Ventilation of works.

12. Efficiency and health of operators as related to industrial operations.

Apart from the general problem of the industry, members of the Association may, on terms to be decided by the Council, have special information given to them by the Director or staff of the Association, or may have special investigations or researches made for them.

In March, 1920, the Association secured the lease of 50 Bedford Square, W. C. 1 and these premises have been equipped as offices and laboratories, in which research investigators are carrying out intra-mural investigations.

It has been the policy of the Association so far as possible to utilize existing facilities in scientific institutions and in accordance with this policy the National Physical Laboratory at Teddington is proceeding with fundamental researches on behalf of the Association.

Investigations have also been carried out at the Department of Glass Technology, University of Sheffield on behalf of the Association and extensive investigations on problems of founding and forming will be carried out by the Association at the plant of the Department of Glass Technology, Sheffield.

In conjunction with the British Refractories Research Association extensive researches into the fundamental principles underlying the manufacture of refractories for the glass industry and their industrial application are being carried out.

The Association is also coöperating with the Industrial Fatigue Research Board in conducting research investigations into the psychological and physiological problems affecting organization and productive operations of the industry.

Apart from work undertaken by associations and scientific institutions and at factories of members on behalf of the Association, arrangements have been made for scientists, other than those on the staff of the Association, who have specialized in certain branches of scientific investigation as applied to this industry, to undertake researches.

A vast amount of work lies before the Association, and, while realizing the limitations of universities in their relation to industrial research and appreciating their services to industry in furnishing both ideas and trained investigators, the Council is, in its endeavors to solve such of those problems of the glass industry as lend themselves to investigations along academic lines, anxious for the close coöperation of those universities and scientific institutions having equipment and facilities available, and it is believed that as its work progresses the Association will become the center of scientific and industrial research into problems of the glass industry for the Empire.

50 Bedford Square
London, W. C. 1

BRITISH SCIENTIFIC INSTRUMENT RESEARCH ASSOCIATION

By J. W. Williamson

The British Scientific Instrument Research Association is one of the earliest research associations formed under the scheme of the Committee of Privy Council for the promotion of scientific and industrial research. It was founded, as is stated in the third annual report of that Committee, "through the efforts of the optical industry, guided by the whole-hearted energy and zeal of Mr. Conrad Beck, the President of the British Optical Instrument Manufacturers' Association." The Association was incorporated on the 30th of May, 1918, and was established on lines broad enough to include all scientific instrument makers, and also, in view of the intimate relationship between optical glass and optical instruments, the manufacturers of optical glass. In May, 1919, a group of firms representative of the electrical scientific instrument, electro-medical and X-ray industries joined the Association, which may now claim to be, what the above named report of the Committee of Privy Council stated in August, 1918. It had every pros-

pect of becoming the representative industrial body dealing with the application of science to the manufacture of scientific instruments. The Association was fortunate in securing from the outset as its Director of Research Sir Herbert Jackson, K.B.E., R.F.S., formerly Daniell Professor of Chemistry, now Emeritus Professor at the University of London, King's College. Mr. J. W. Williamson was appointed Secretary of the Association and, later, Mr. H. Moore was appointed Assistant Director of Research with especial reference to the electrical and X-ray researches of the Association.

The first task of the newly formed Association was to secure suitable premises for offices and research laboratories and in November, 1918, the remaining term of the lease of 26 Russell Square, was purchased and the Association entered into possession on Armistice Day, November 11, 1918. Steps were immediately taken to effect the necessary structural alterations and to equip the premises with laboratories and secretarial offices and the Association has now a relatively well equipped research institute, with a scientific staff of six research workers, all university graduates experienced in research, in addition to the Director of Research and the Assistant Director of Research.

The Chairman of the Association is Mr. A. A. Campbell Swinton, F.R.S., whose high scientific attainments and wide experience have been and will be of great benefit to the Association.

The Council of the Association consists of fifteen elected members, five co-opted members and five members appointed by the Department of Scientific and Industrial Research. The addition to the elected members of Council of these Department representatives and co-opted members has been of great service to the Association in enabling the Council to view from a wide angle and to a far horizon the varied problems presented to it, without impairing the predominant interest of the members representing the industry or modifying the necessary bias of the Association's activities towards practical results.

The main and immediate functions of the Association, the Council have agreed, are

(*a*) To prosecute research into the questions of pure and applied science arising out of the urgent needs of the scientific instrument industry;

(*b*) To take long views and to investigate those questions, whether of pure or applied science, upon which the future of the industry may be conceived largely to depend;

(*c*) To investigate systematically and continuously the field of application of scientific instruments.

In considering how far the Association has followed out these guiding principles the research work of the Association during the past four years may be classified conveniently under three heads: (1) Fundamental researches; (2) researches on urgent problems of immediate application to

the industry; (3) researches and investigations to solve technical difficulties or to elucidate theoretical questions arising from time to time in the workshops of members of the Association.

It must be remembered that the first year of the Association was necessarily devoted mainly to organization; to the survey of the field of research and the mapping out of the researches; to the acquirement of premises and their equipment with laboratories; and to the engagement of a Research Staff.

I. Fundamental Researches

Among the researches of a fundamental character that have been initiated by the Association, the following are selected as likely to be of interest to the members of the AMERICAN CERAMIC SOCIETY:

1. Abrasives and Polishing Powders.—Although these researches have produced results of immediate practical benefit to the industry, as will be shown later, they have involved thorough investigation of the fundamental scientific principles involved in the preparation of materials for the abrasion and polishing of solid surfaces, and they have established principles which must be the foundation of future practice.

2. Durability of Optical Glasses.—A prolonged research on methods of testing the durability of optical glasses and of determining the causes which give rise to deleterious changes in certain types of glass has involved much research of purely scientific character into the fundamental relations between chemical composition and physical properties. Although the report on this research, which has been published for general circulation, gives a general account and estimate of the durability of various types of glasses, which will prove of value to the industry, it is, perhaps, especially for its contribution to the knowledge of the behavior of various types of optical glasses under varying conditions that this prolonged research is to be valued. Further investigations in this field are being undertaken.

3. New Types of Optical Glasses, Neutral Glasses and Colored Glasses.—The work that has been done on new types of optical glasses, on neutral glasses and on colored glasses, apart from those results obtained which are or may be of immediate practical value, is mainly of a fundamental character, involving research into the relations of chemical composition to optical properties and into the chemical conditions and physical states of aggregation of coloring materials in glasses correlated with the composition of the glasses.

II. Researches on Urgent Problems of Immediate Application to the Industry

Among the researches which have already produced results immediately applicable and of economic benefit to the industry, the following may be mentioned by way of illustration.

As the outcome of the researches on abrasives and polishing powders, products have been prepared, one of which, known as "Sira" rouge, has been manufactured on a large scale and has been for nearly two years in regular use in the workshops of optical members of the Association; the other, to be known as "Sira" abrasive, is now in course of large-scale manufacture for the Association and is being regularly supplied to members.

The "Sira" rouge has been found to be superior to pre-existing rouges and polishing powders for the polishing of high-grade lenses and prisms. Those members of the Association now familiar with its use claim that it takes less than the time previously required for comparable polishing; owing to its purity and uniformity it is less liable than any other known polishing powder to cause sleeks; and it gives a finer finish. For the production of the highest class of work it is now used exclusively by the members referred to.

The "Sira" abrasive has now been thoroughly tried out, under industrial conditions, in the workshops of several members of the Association. Here it may be briefly stated that by its use the time of grinding is reduced by two-thirds, with the added advantage of eliminating hand work and the need for grading the abrasives; and the time of polishing surfaces ground with this abrasive is not more, and on the average is less, than two-thirds of the time required to polish surfaces ground in the usual way. It seems, moreover, to have shown promising results in large-scale experiments by members of industries other than the optical and scientific instrument industry. Arrangements are being made for its regular manufacture and supply not only to members of the Association, but to others who employ abrasives in their industrial processes.

We have given above merely a few examples of researches, fundamental and of immediate application, on subjects, or cognate to subjects, in which members of the AMERICAN CERAMIC SOCIETY are interested. The Association has prosecuted and brought to fruition other researches, including electrical and X-ray researches, which are less suitable for reference in the present article.

III. Researches and Investigations to Solve Technical Difficulties or to Elucidate Theoretical Questions Arising in the Workshops of Members of the Association

The work done under this head has been of the most varied and diverse character, and is increasing as the members of the Association realize progressively the help that the Association can give them in these directions. The problems dealt with include the improvement or modification of materials already in use, the finding of substitutes for existing materials, the use of new materials, and the explanation and solution of technical difficulties in manufacture.

The work that has been done under heads II and III above has been not only of direct benefit to the members, but it has kept the Director of Research and the Research Staff in close touch with the practical needs and difficulties of the industry. The result has been to create, slowly but surely, a research institute of a valuable and, to a great extent, a new type, because of the intimate special knowledge which the Association has acquired of the particular needs and working conditions of the industry. It is stated in the last annual report of the Association that in reviewing the work done during the last four years the Council of the Association recognize, as they are confident the members also recognize, that the Association is a concrete example of the benefits to be obtained from organized, coöperative research, in which the scientific worker, the manufacturer and the user each plays his appropriate and coördinated part.

It may be well to point out that, besides the specific researches included in the program of research, the Association in its character as the scientific center of the industry, is called upon from time to time to assist the industry by contributing from a scientific standpoint suggestions and criticisms to the appropriate Government and other quarters on such matters as the supplies of raw materials and the manufacture in this country of products essential to the development of the British scientific instrument industry. Much work in this direction has already been done. Moreover, users of scientific instruments have already brought to the notice of the Association, and, as the Association becomes better known, will doubtless tend increasingly to bring to its notice, their specific needs. In this way the Association will perform a useful scientific liaison office between the users and the manufacturers. Already, by means of conferences and otherwise, the Association has enabled the manufacturing members to become better acquainted with the scientific needs of the users, and the users to appreciate the limitations imposed on the manufacturers by design, material or other conditions.

In the task of industrial reconstruction after a devastating war which the British scientific instrument and optical glass industries, in common with other British industries, have now to face and accomplish, their most potent means must be the extension of scientific research to the varied problems of the industries. In this work the coöperative research of the Association and the particular research of the individual firms are essential and complementary. The work of the Association not only does not supersede but emphasizes the need for, and assists, the scientific research undertaken by individual firms. In the same way the pure science research of the universities and kindred institutions is essential and complementary to all research carried out by the research associations or by industrial firms. The universities and their like are the great sources of pure scientific research and to them we look for that fundamental work which

probably in many cases not of immediate applicability to industry is bound to be the foundation of future guiding principles. Nowhere is this more fully recognized than in the British Scientific Instrument Research Association. Its work is also largely purely scientific but to fulfil its purpose of immediate utility to its relevant industries it necessarily cannot always follow through to completion the numerous lines of investigation which arise out of the problems studied.

CLIFF BANK HOUSE
UPPER CLIFF BANK
STOKE-ON-TRENT, ENGLAND

THE PROGRESS OF TECHNICAL CERAMIC SCIENCE IN GERMANY SINCE THE DEATH OF HERMAN SEGER (1893)

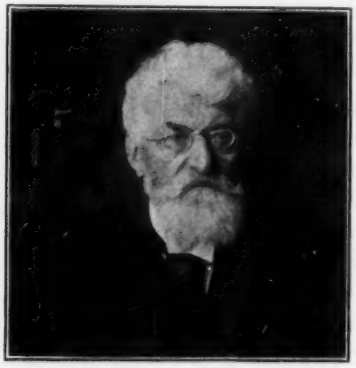
BY K. H. ENDELL AND R. RIEKE
(Translated from the German by E. E. Pressler)

I. The Period from the Death of Herman Seger to the Founding of the German Ceramic Society

Following the death of the early master Herman Seger, the founder of the ceramic science in Germany, the development of ceramic science in Germany proceeded along diversified lines. Some investigations were conducted upon the problems of the domestic porcelain manufacture in the testing station in Charlottenburg (Charlottenburger Versuchsanstalt). These were extended to include all branches of ceramics.

In the testing station, the following men have been active at various times: E. Cramer, H. Hecht, M. Marquardt, E. Berdel, M. Simonis, R. Rieke, K. Endell, W. Steger.

Many investigations for the growing industry were made in the laboratory for Tonindustrie (Tonindustrie-Laboratorium), which had been established by Seger. The society, "Kalk-Ton-Zement Verein," which was then in a state of thriving growth, gathered in its annual meetings all scientists in the field of ceramics. We find in its annual reports, which are printed by the publishers of *Tonindustrie*, contributions of the leading ceramic men of that time. The Society, "Verein Deutscher Fabriken feuerfester Produkte," did meritorious work as a scientific society from the beginning of the new century up to the outbreak of the War. Work was done upon various problems relating to the refractory industry and its commercial phases. The official medium was *Tonindustrie*, while more



DR. HEINECKE

elaborate works were given out elsewhere. In 1910 and 1911, Professor F. Hofmann worked in the technical institute," Physikalisch-technische Reichsanstalt," in Charlottenburg, upon the fusion point of Seger cones under laboratory and industrial conditions. These and other investigations are found in the annually published proceedings of the Society, published by *Tonindustrie*, Berlin.

In the field of glassware, Mylius worked out in the Institute "Physikalisch-technische Reichsanstalt" a method (Glas-Eosinprobe), of determining the resistance of glasses to chemical action.

Independent development was shown by the Society "Verein Deutsche Portlandzementfabrikanten," which later incorporated with it "Verein der Eisenportlandzement- und Hochofenzementwerke." The Society was identified in the outstanding personality of the noted cement investigator, Wilhelm Michaelissen. Through scientific and practical work, and leading suggestions by the foremost scientists, various problems of general and special interest within the scope of the Society were solved. The laboratory is in Karlshorst, and has been directed since 1910 by the able Dr. Framm.

The producers of cement using refractory slags, through the Society, "Eisenportlandzement- und Hochofenzement-Verein," established a new institution for slag investigation (Schlackenforschungs-institut) in Düsseldorf in December, 1922. The Institute is under the direction of Dr. A. Guttmann and Dr. Richard Grün.

Investigations for optical glasses and glasses for technical glasswares were made almost exclusively by the firms Schott and Genossen in Jena, and the Sendlinger Optical Glass Works in Berlin-Zehlendorf.

II. German Ceramic Society

On June 13, 1913, the Society of the Associated Ceramic Works in Germany (Verband Keramischer Gewerke in Deutschland) established a special division, designated as the "technical scientific division" for the two-fold purpose: (1) of furthering the technical and scientific phases of ceramics, and (2) harmonizing the efforts of theoretical and practical workers of ceramics. This division held annual meetings, before which papers were read. These were published as annual reports in Coburg, under the designation: "Berichte der technisch-wissenschaftlichen Abteilung des Verbandes Keramischer Gewerke in Deutschland" (Vol. 1, 1913; Vol. 2, 1914; Vol. 3, 1917; Vol. 4, 1918, Vol. 5, 1919).

In a meeting held September 29, 1919, this division was reorganized. Its field was extended to include all ceramic science, and accordingly it soon thereafter assumed the name "Deutsche Keramische Gesellschaft." Since the middle of 1920, the German Ceramic Society has issued its own bi-monthly reports. The Society is supervised by eleven trustees, who are

representatives of the technical ceramic sciences. There is also a working committee consisting of eleven representatives of the Society of the Associated Ceramic Works and other technical ceramic societies, and twelve representatives of ceramic science connected with universities, trade schools, and ceramic periodicals. For the consideration of special problems, committees have been named (1) for problems of firing; (2) for problems relating to lead; and (3) for protection in industrial rights.

In 1920, a drying establishment and an installation of ceramic machinery and equipment was secured for the benefit of information to members.

The direction of the scientific work of the German Ceramic Society rests with R. Rieke, who is also director of the chemical-technical experiment station of the State Porcelain Factory (Staatliche Porzellan-Manufaktur), and Professor of the Technical University. The Society renders excellent service in furthering scientific ceramic work, in giving technical assistance to the general ceramic industry, and in promoting ceramic instruction.

The Society is in process of substantial growth, and includes as members most firms in the ceramic industry in Germany. The present membership is about 1400. The business address is Berlin, W. 30, Victoria Luise Platz 11.

In the summer of 1922 the German Society of Glass Technology was organized. This Society aims to serve the glass industries as the ceramic society serves the clay industries.

III. Biographical Notes on the Present Leaders in Technical Ceramic Science in Germany

Biographical notes are being given on the following men: E. Berdel, E. Cramer, K. Endell, H. Hecht, A. Heinecke, G. Keppeler, J. Koerner, F. Kraze, W. Pukall, R. Rieke, W. Stegers.

E. BERDEL

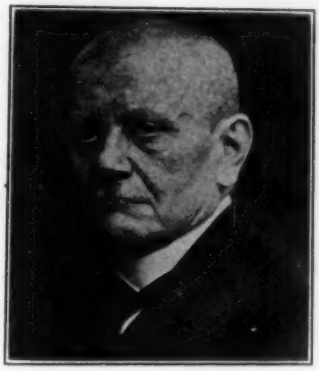
Eduard Berdel

E. Berdel was born Feb. 1878 in Zweibrücken. He completed the course of the local humanistic gymnasium in 1896. Studied chemistry and natural science in the Universities of Munich and Erlangen. By virtue of his dissertation "Beitrag zur Kenntnis der Legierungen" the title of Doctor of Philosophy was conferred upon him by the University of Erlangen in 1901. In 1899, Dr. Berdel became assistant in the chemical laboratory of the University of Erlangen. In 1902, he was made assistant in the chemico-technical experiment station of the Royal Porcelain Works (Königliche Porzellan-Manufaktur) in Berlin, where he remained until 1905 when he was made

instructor in the Royal (now State) Ceramic Trade School in Hoehr. Since 1913 Dr. Berdel has been director of the State Ceramic School in Hoehr, near Coblenz. He has written many articles for the technical press, especially for *Sprechsaal*.

Eduard Cramer

E. Cramer was born in 1859 at Bochum, Germany. He completed the work of the Public Trade School in Bochum and attended the Technical Universities of Hannover and Berlin from 1877 until 1881. During this time he was assistant chemist in chemical technology. In 1883–1886 he was assistant chemist to Seger in the experiment station of the Royal Porcelain Works in Berlin. In March 1886 Mr. Cramer entered the chemical laboratory for *Tonindustrie* and *Tonindustrie-Zeitung* of Seger and Aron, taking the place of Dr. Aron, and later became partner.



E. CRAMER

Mr. Cramer's varied services for the German building material industry have been recognized by the leading trade associations by election to honorary membership. He is honorary member of "Bund deutscher Fabriken feuerfester Erzeignisse," "Verein Deutscher Kalkwerke" and "Reichsverein der Kalksandsteinfabriken." He is a trustee of a number of other societies, and advisory member of several scientific committees. The ceramic hand-book "Handbuch der Tonwarenindustrie von Bruno Kerl" revised jointly by Cramer and Hecht is recognized as a standard work. Because of his extensive fundamental knowledge, Cramer's activities and knowledge of materials cover a very wide scope.

Kurd H. Endell

Kurd H. Endell was born in Stade in 1887. He studied in Lausanne in 1905, at Grenoble in 1906 and at the University of Berlin 1907–1910 in the latter year taking his Ph.D. degree. In this same year he became assistant in the experiment station of the State Porcelain Factory, and in 1911 was made assistant in the Institute of Mineralogy at the University of Berlin. Since 1913 Dr. Endell has been instructor of technical building science in the Charlottenburg Technical University. In 1919 he was appointed resident scholar for mineral-chemistry and its industrial application. During 1917–1918 he was assistant in scientific research for the Optical Glass Firm of G. P. Goerz of Berlin and the Sendlinger Optical Works in Berlin-Zehlendorf. From 1918 until 1920 he was assistant in scientific research for "Deutsche Portland Zement-verein." He was also publisher of *Zement* from 1919 to 1921. Dr. Endell is a member of the following technical societies: "Vereindeutscher Eisenhüttenleute," "Metallhütten-und Bergleute," "Deutscher Chemiker," German Ceramic Society, English Ceramic Society, Society of Glass Technology, AMERICAN CERAMIC SOCIETY, and American Society for Testing Materials.

K. H. ENDELL

Extensive travels for industrial survey were made in 1908, 1911, and 1921 in Europe, and in 1922 in United States and Canada. Dr. Endell has written many articles for both German and American publications of technical value to ceramists.

Herman Hecht

Herman Hecht was born in Neuhof near Stralsund in 1860. He was a student in chemistry and natural science in Berlin, graduating in 1887. From 1886 until 1897 he was assistant and then head of the Chemical Technical Experiment Station of the Royal Porcelain Works in Berlin. In 1897 he became connected with the Charlottenburg Technical University, as instructor in ceramics. From 1897 until 1900 he was a member of the German Patent Office, and in 1898 was elected to State Council. Since 1894 he has been joint owner of the chemical laboratory for *Tonindustrie* and associate editor of that publication. Since 1909 he has also been Editor of *Keramische Rundschau* and since 1888, has contributed many writings on technical subjects.

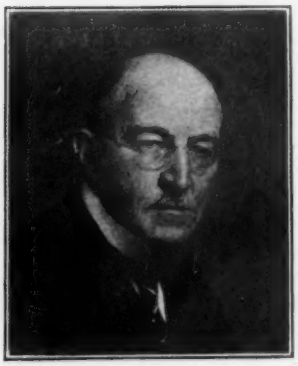
H. HECHT

Albert Heinecke

Albert Heinecke was born at Tiedenwiese in Hannover in 1854. He studied chemistry in Leipzig and Berlin, and in 1879 became assistant in the Royal Porcelain Works, where he advanced from the position of industrial chemist to manufacturing director. Under his direction the factory made marked progress in technical and artistic developments. Dr. Heinecke retired in 1914 after thirty-five years of active work in this factory.

Dr. Heinecke has been instrumental in the development of the ceramic industry through both his written and spoken contributions. In recognition of his services in elevating the science of ceramics in Germany, the German Ceramic Society elected him to honorary membership, and, within recent years, the Technical University of Berlin conferred upon him the title of Doctor of Engineering.

Gustav Keppeler



GUSTAV KEPPELER

Gustav Keppeler was born in Heilbronn in 1876. He studied in Stuttgart and Heidelberg, and was assistant in Karlsruhe and Darmstadt for several years and later instructor. He was professor in the Technical University of Hannover, giving technical instruction in the peat, clay and glass industries. Mr. Keppeler studied problems of fuel technology and general inorganic chemistry, and, through investigations in clay casting conducted jointly with Spangenburg, became interested in the technical ceramic science. The investigation led to a valuable technical application for the manufacture of fire clay wares of heavy construction, such as bath tubs, and also applicable to the grog industry (German Patent 201,987).

After a short connection with the technical experiment station of the Royal Porcelain Works in Berlin, Keppeler in 1908 became interested in instruction and research in ceramics, in the newly established institute in Hannover. Here he has since rendered service in ceramic lines both through instruction and investigation. His chief object of investigation has been the subject of the plasticity of clays. Processes of casting were also developed. Keppeler also became known through his service in assisting in the publication of Dralle's "Die Glasfabrication." The primary object of his investigations relative to the publication of this book was to establish the relation of the composition of glasses and their resistance to chemical action.

After the death of Robert Dralle in 1918, Keppeler undertook the compilation of a second edition of the collected works of Dralle. Within the course of the next year, a thoroughly revised second edition will be forthcoming. Mr. Keppeler, as Editor, would appreciate any suggestions from American sources upon subject matter to be included, so that he might more fully consider American industrial requirements and contributions.

Joseph Koerner

Joseph Koerner was born in Alsace in 1872. He studied chemistry in the Universities of Strassburg, Leipzig and Erlangen, receiving the degree of Ph.D. from the last named University. Koerner was assistant in chemistry in the University of Erlangen for two years and in 1901 entered the Experiment Station of the Royal Porcelain Works of Berlin. In 1905 he assumed the direction of the Imperial Majolica Works at Cadinen. Since 1907 he has been Editor of *Sprechsaal*.

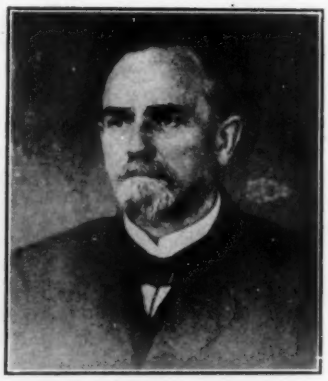
J. KOERNER

Fritz Kraze

Fritz Kraze was born in 1878 in Silesia. He attended the Technical University in Berlin and became assistant in Mineralogic-Geology in this school. He was also co-worker with Councillor Dr. Hirschwald in his work "Die Prüfung der natürlichen Bausteine auf ihre Wetterbeständigkeit." During 1903–1904 he was industrial engineer for the enameling works, "Silesia," and certain iron works in Upper Silesia. In 1904 he was appointed instructor and head of the Division of Silica Technical Instruction in the municipal "Friedrichs-Polytechnikum" in Cöthen-Anhalt. Here he gave instruction in ceramics, refractory products, brick manufacturing, technology of cement, mortar and artificial stone manufacturing, glass manufacturing, and iron enameling. Besides the training of engineers in the above named branches of the silica industry, Prof. Kraze also served as technical advisor in this industry. He interests himself particularly with problems of iron enameling. He is consulting advisor for The Society of German Enamel Works.

FRITZ KRAZE

Wilhelm Pukall



WILHELM PUKALL

Wilhelm Pukall was born in West Prussia in 1860. He completed his studies in Berlin, receiving the degree of Ph.D. For ten years, he was industrial chemist in the Royal Porcelain Works of Berlin-Charlottenburg. He then assumed the direction of the newly established ceramic trade school in Bunzlau in Silesia, which position he still holds. To this institute has been delegated the problem of training students for the theoretical and practical aspects of the ceramic industry. In November, 1922, the State Ceramic School in Bunzlau celebrated the twenty-fifth anniversary of its founding, and upon this occasion the Technical University of Breslau conferred upon Pukall the title of Doctor of Engineering. He is an honorary member of the German Ceramic Society. Dr. Pukall has written numerous technical articles, and in 1907 published a text-book on Ceramic Calculations.

REINHOLD RIEKE

Reinhold Rieke

Reinhold Rieke was born in Riga, Russia, in 1881. He studied chemistry in Freiburg and Leipzig. He then became assistant in the department of technology of the University of Freiburg, completing his studies there. In 1905, Dr. Rieke became chemist of the technical-chemical experiment station of the Royal Porcelain Works of Berlin-Charlottenburg. During 1908 and 1909 he was technical assistant in this factory. In 1919 he became instructor in the Technical University of Charlottenburg, and in 1921 was appointed instructor of ceramics. He also received the appointment of head of the experiment station in the Royal Porcelain Works. In 1919 he was assigned the direction of scientific and literary work of the German Ceramic Society, and in 1920, he established the "Berichte der Deutschen Keramischen Gesellschaft," which he still edits. In 1922 he became Assistant Professor in the Technical University of Charlottenburg. Since 1905, Dr. Rieke has published many papers on ceramic subjects.

WALTER F. STEGER

Walter F. Steger

W. F. Steger was born in Silesia in 1889. He studied chemistry in the Universities of Berlin and Jena, and received his Ph.D. degree in 1913. He is now chemist of the technical-chemical experiment

station of the Royal Porcelain Works in Berlin, and is assistant to Dr. Rieke. Here he has conducted investigations upon porcelain glazes, stoneware glazes, and fireproof building materials. The results of his investigations have been published in various German publications. In January, 1923, he becomes a member of the Government Patent Office in Berlin, connected with the Division of Ceramic Patents.

IV. Instruction in Ceramic Science in Germany

The institutions giving instruction in ceramic science in Germany may be divided into four groups.

The first group includes trade instruction shops in industrial continuation schools, and departments in art and industrial-art schools. The training in these is limited to purely handicraft or artistic lines. In only a few schools of this class is technical-chemical instruction given.

The second group includes the distinctly technical ceramic schools, and schools for instruction in brick manufacture. Such schools are found in Hoehr near Coblenz, in Bunzlau, Selb, and Landshup. Of these the first two named are the largest and best known. These schools treat of all branches of ceramic science, except the one in Selb, which restricts its work to the porcelain industry.

A third group consists of institutions giving instruction of a more purely technical character. Of these the most important is the Friedrichs-Polytechnic Institute in Coethen.

A fourth group is made up of technical universities. In most of these, the science of ceramics is given only slight consideration. In some, only general lectures in ceramics are given, and only in Charlottenburg, Breslau, and Hannover are provisions for practical training found. The best advantages are offered by the Charlottenburg Technical University, where students of ceramics have access to the laboratory and equipment of the technical ceramic experiment station of the State Porcelain Factory in Berlin.

V. Investigation and Experiment Stations

The institutions named below conduct systematic investigations of problems in ceramic science.

(1) Physikalisch-technische Reichsanstalt. The work of determining the fusion point of Seger cones was done by F. Hofmann at this station, and in 1912 Dr. Hofmann, K. Endell, and Dr. Rieke made the first satisfactory determination of the melting point of cristobalite in Germany. This was done at the same time, but independently, by C. N. Fenner of Washington, D. C.

(2) Staatliches Material-Prüfungsamt. This Institution in Berlin-Dahlen was commissioned by State authorities to establish norms of re-

fractory rocks. Important investigations of the heat conductivity of refractory rocks were made here by E. Heyn and R. Bauer.

(3) Deutsche Gesellschaft für Materialprüfung der Technik. In 1920, this Society authorized a committee to work on simplifying methods of testing porcelains, which devoted itself particularly to methods of mechanical testing.

(4) Tonindustrie-Laboratorium. This Institution keeps in close touch with private industry. Since Seger's death, it has been directed by E. Cramer and H. Hecht.

(5) Geologische-Landesanstalt. This Institution occasionally works on ceramic problems.

VI. Periodic Ceramic Literature

Of the technical periodicals now published in Germany, those of chief interest to the members of the AMERICAN CERAMIC SOCIETY are the following:

Keramos: periodical for ceramic art, published since 1922 in Munich.
Die Kachel- und Töpferkunst: published since 1922 in Berlin.
Zement: Periodical of cement production and utilization published since 1912 in Charlottenburg.
Die Glashütte: published in Dresden.
Die Glasindustrie: industrial publication of Spaeth and Linde in Berlin.

Many articles bearing upon ceramic science also appear in the published annual proceedings of "Verein Deutscher Portland-Zementfabrikanten," "Deutscher Kalkverein" and "Deutscher Gipsverein."

Papers bearing upon refractory materials are often published in *Stahl und Eisen*, and also in reports of "Verein Deutscher Eisenhüttenleute" in Düsseldorf, and *Zeitschrift für angewandte Chemie* in Leipzig.

The rising technical science in Germany has successfully entered industrial fields. Many firms have established great laboratories, such as porcelain factories for physical and chemical testing of chemical and electrical porcelains; optical glass manufacturers for the particular requirements of optical glasses; and manufacturers of refractory materials for tests of refractory behavior. Great industrial laboratories devote themselves exclusively to the development of new ceramic colors, glazes and enamels.

THE CERAMIC INDUSTRIES OF FRANCE SINCE THE END OF THE 19TH CENTURY

By A. A. Granger[1]

(Translated from the French by F. G. Jackson)

It can be said that the ceramic industry is represented in France in all its branches; bricks, tile, paving brick and terra cotta; refractories; earthenware and china; stoneware; hard and soft porcelain.

Brick, Tile and Terra Cotta

There are in France a good many brick plants of very varying importance. They may be divided into two types. The first, still using the old processes, treat slightly argillaceous earth which they mould sometimes by hand and sometimes in hand presses, and burn them in cone kilns. Such small hand brick plants are scattered throughout the country. They do only a local business and employ but few people. Their number tends to diminish progressively.

Gabriel Faugeron

Contrasted to these ancient plants there are modern plants capable of making beautiful bricks by mechanical processes. They generally use the mud process. The dry press process is exceptional. The brick industry is much occupied with the question of driers and cannot decide what type is better for a given clay. The bricks are burned, in the majority of cases in kilns of the Hofmann type in most part using coal, and a few using gas. Some of the brick companies make other products such as terra cotta.

What I have said of bricks may be repeated about tiles. There are still in France in the country, small hand tile factories and there are mechanical tile factories. The form of tiles made in the country is varied. The mechanical factories principally make rectangular tiles. The mechanical tile is made by pressing a cake of clay conveyed on a belt to the press. This may be a soft or a hard cake. In the first case they are put in plaster molds and in the second in metal molds. The two processes have their advantages and their inconveniences. They are baked in continuous kilns as are the bricks. The Hofmann kiln can be used for bricks and tile at the same time. The kiln is set with the bricks arranged to protect the tile from the coal dust which would make spots.

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Coping bricks are made by spinning and repressing.

There are terra cotta factories throughout France but particularly in certain centers. The North, the Departments of Saone and Loire, and the vicinity of Marseilles, are the greatest producers. It is difficult on account of the disorder brought on by the War to give statistics of these factories but without great error one can say that the terra cotta industry employs from 4000 to 4500 men spread over 700 factories.

Refractories

Refractory clay products are made all over France. The bricks are made by machine. The dry press process is very seldom practiced. Special shapes are moulded.

In the fabrication of gas retorts they have introduced mechanical methods, but this method is not used widely to my knowledge.

A certain number of factories use continuous kilns but one still finds intermittent kilns in this industry.

The making of special refractories has not had a serious development. France does not have enough magnesia to permit her to develop the manufacture of magnesia bricks. Nor can she work, except on a small scale, with magnesia from eastern sources. The chrome brick manufacturing is not a flourishing industry. The silica brick alone has been the object of an interesting research especially during the War in order to assure of its production. It does not seem up to the present that one can arrive at a concise determination of the characteristics of the quartz in silica bricks.

Artificial corundum has been used in several refractories. As the factories making refractories are not always strictly limited to refractories it is difficult to give an estimate of the number of plants and persons employed.

Pottery

Pottery is made in France in transparent enamel or opaque enamel and china and is used especially as kitchen utensils and household articles (pots and pans, utensils for baking and mash bowls, etc.). This industry has not made any noticeable progress for many years. It extends over all of France and still follows the old methods. In certain sections one may see the enamel prepared with Galena or lead sulfide as the principal ingredient. Besides the enamel pottery one must cite the colored clay potteries.

The opaque enamel industry occupies at present a very precarious position. This type of pottery has not been able to compete with china, in part because of its technical faults and in part because of the incapacity of the factories which have made no improvements in one hundred years.

They still make some Dutch tile stoves and some hearth brick both of which are becoming more difficult to sell on account of improved heating methods. A very small number of factories make *bibelots*. The importance of their production is small in comparison to those making china.

The china industry is much more important than the pottery industry. From statistics taken sometime ago it is certain there are least 12,000 workmen. The largest plants are grouped principally in the region of the department of the North (Saint Amand, Orchies, Onnaing in the East (Lunéville, Badonvillers, Pexonne, Longwy, Sarreguemines), in the district near Paris (Choisy le Roi) in the boundaries (Montereau) in the center (Digoin). These factories total 300 kilns each of 100 to 150 cubic meters.

The French manufacture of china is not exactly like the English. The raw materials: silica (with a little quartz sand, more or less mica or feldspar), refractory clay, white burning pegmatite, and native kaolin. English clays are used (ball clay) and English kaolins.

The clays are found principally in the basin of the Marne and equally in the region of Charentes. The kaolins used form the central rock (the Collettes, Beauvoir) from Bretagne (Lorient, Plémet, etc.) the kaolins from the Limoges region being reserved for the production of porcelain. Flint is abundant in the most of France and the fusible rocks are also abundant.

In the preparation of the paste one has recourse ordinarily to the wet way that is to say to mix the raw materials in a slip. The Alsing mill is generally used for the grinding.

The work is entirely mechanical. Casting is employed quite largely as it demands no especial training. In some factories it has completely taken the place of jiggering. The tendency is to establish automatic machines for the preparation of the paste and the formation of the ware. The machinery of this has been especially studied by M. Faure of Limoges.

The greatest progress made in the manufacture of china is due to Mr. Faugeron who first succeeded with a continuous glost kiln and then later with a continuous biscuit kiln. From 1899 the glost kiln which he had constructed at Montereau was a success. Before good results were obtained a second kiln was constructed in 1900 and in 1901 for the burning of the biscuit. The Faugeron kiln is a tunnel kiln with a particular arrangement for good gas circulation and consequently even burning. The experiments performed almost at the same time with the continuous circular kilns have not given the same satisfaction and in the china industry of France the Faugeron tunnel kiln is considered to be excellent.

The introduction of glazes without lead dates from about 1904; at least it is at about that date that the factory at Montereau commenced to employ them industrially. This use of glazes without lead, necessitated for

hygienic reasons, is accountable for many colors developing badly. These glazes without lead have a luster less shiny than those with lead.

The expense of engraving being very high there is actually a tendency to development of decoration by air-blast and the impression by a rubber buffer.

I will cite in closing the perfecting of a machine of M. Centore which presses, with the aid of one workman and two boys, from ten to twelve plates a minute or a minimum of 4800 plates a day. The same machine may be used on any sort of shape not too irregular or too exaggerated.

I cannot leave the faience without a word on terra cottas and architectural brick. These products are earthenware since they are enameled and are made by the factory which make both earthenware and china. In France there is a large consumption of Dutch tiles for walls. These tiles are made in some places together with pottery and sometimes in factories producing all branches of ceramics.

Stoneware

The manufacture of stoneware for domestic use is for the greater part still in the hands of little potteries whose work follows the mode of the most primitive potteries. The largest pieces which cannot be turned are often made by modeling. The most important groups are those of Beauvaisis (La Chapelle aux Pots), of Normandy (Noron), of Nièvre (Saint Amanden Puysaie), of Cher (La Borne), etc. There are also some small modern factories such as those of Seurre and Pouilly on the Saone, of Roanne for chemical stoneware and sanitary pottery. The first of these factories belonging to the Société Jacob at Delafon uses Dinz continuous kilns. This operation which to my knowledge is not common has been considered a great improvement since it permits of the burning of large pieces in a continuous furnace.

The stoneware made by the small potteries is composed of simple mixtures of clays burning naturally into stoneware. In the larger factories more is known about the composition of their clays. The burning of French stoneware rarely attains cone 9, and sometimes as low as cone 5. Beside the stoneware potteries there is also an important manufacture of stoneware bricks. Several of the factories work stiff mud which they cut and afterwards press, but generally the production follows the dry press process, using a hydraulic press. The north of France exports a large amount of this product, particularly in polychrome and crusted bricks. The burning is still done in intermittent kilns. Some interesting experiments have been made with the Dressler kiln and permit us to predict that the tunnel kiln will take the place of the intermittent kiln in this industry.

Porcelain

The manufacture of hard porcelain has but little importance in France. The two important centers of manufacture are in Berry (Vierzon) and in Limousin (Limoges). The porcelain industry in these two regions is divided into two industrial groups one of which is the *patiers* who deliver the paste all prepared to the factories, the latter molding, cutting and decorating this paste. The raw materials are in part French, and before the War considerable quantities of English kaolin and Scandinavian feldspar were used. The beds of kaolin cited apropos of china contribute some of the kaolin that is used but there are in the outlying regions, principally in the South, important beds of kaolin, rock and feldspar. In the region of the Pyrénées we also find beds of feldspar and other kaolinite rock deposits. The *patiers* are always established if possible along the rivers in order to utilize hydraulic power. La Société des kaolins et Pâtes Ceramiques of Limousin have a number of well equipped mills. Profiting by the neighboring falls the region around Limousin uses electricity as much as possible.

The progress made in the production of porcelain is important. The machines for forming the ware have been notably improved by M. M. Faure, and by M. Rouchaud who have designed plate machines almost absolutely automatic.

M. Charbonnier very recently has perfected a machine to make the saggers and has also worked out a method of employing pressure in the casting process.

The production of electrical porcelain has resulted in improved presses especially for the production of large pieces. Until the present time the burning of porcelain in continuous kilns has had no great adherents.

Few of the factories make laboratory porcelain. The Manufacture de Bayeux has acquired a certain fame in making divers laboratory articles. M. Frugier of Limoges during the period of hostilities made some interesting pieces. Since the War the number of kilns in use has not changed much at Limoges, but the number of workmen has diminished (about one-third). A recent count placed them at a total of 18,000.

Soft porcelain (bone china) is not made except in a small qauntity at Sarreguemines. Soft frit porcelain apart from one or two isolated attempts does not seem to have been crowned with success, and is only made by the Manufacture of Sèvres.

Manufacture of Sèvres

The Manufacture of Sèvres has for its principal product hard porcelain which is made in two forms. (1) The hard porcelain, called old porcelain, and a porcelain with a very aluminous base:

SiO_2	60.58
$Al_2O_3.Fe_2O_3$	31.77
CaO	4.00
$K_2O.Na_2O$	3.15

This burns with cone 13 well down. This porcelain is given a glaze of the type: 8.43 SiO_2, 1.05 Al_2O_3, 0.347 (MgO.CaO), 0.653 ($K_2O.Na_2O$). This is a hard glaze used particularly for tableware and for decorating under the glaze.

(2) The hard porcelain called new, which is more siliceous, approaches a china type which burns at cone 9.

SiO_2	69.58
$Al_2O_3.Fe_2O_3$	24.45
$K_2O.Na_2O$	5.34
MgO.CaO	0.66

This glaze has the composition as Seger cone 4: 4 SiO_2, 0.5 Al_2O_3, 0.3 K_2O, 0.7 CaO. It is used more especially for decoration and enamels.

The trade has also made stoneware and has created a type of stoneware specially designed for receiving all sorts of colored glazes. The stoneware of Sèvres is composed of

Plastic clay	56
Flint clay	27
Black fusible mica	26

It is burned to cone 9 like the new porcelain.

The manufacture of soft porcelain or soft French porcelain, using a frit had been abandoned by Brongniart in the first years of his administration about forty years ago. This process, difficult and uncertain as to results, had the added disadvantage of being very expensive. It was also out of fashion, hard porcelain being the vogue.

The taking up again of a delicate process, which had been completely abandoned for forty years, presented great difficulties, since the staff had no longer any traditions. Uncertain records left by the men of the eighteenth century made the investigators exert great efforts which did not succeed until about 1900, in time for the Universal Exposition in Paris. The principal difficulty consisted in the use of a frit made from imperfect glass which made the fusible element. They replaced the frit by a hard glass of the sort used by Stas in his work on the determination of atomic weights. The glass replacing the frit is composed of

Silica sand	77
Chalk	18.40
Saltpeter	16.60
Carbonate of soda	8.50

This glass is less alkaline than the old Sèvres frit. This is an advantage since it is less altered by the water during the grinding and working of the paste. The Sèvres factory has exhibited a certain number of pieces of following formula. The paste contained:

Silica sand	33
Stas glass	46
Chalk	14
Clay	7

and the glaze was composed of 2.5 SiO_2, 0.46 Na_2O, 0.54 PbO.

This type has been modified for the introduction of kaolin in place of clay. Work is still going on to improve it. This soft porcelain lends itself to decoration particularly to the application of enamel.

This factory has experimented with the burning of hard porcelain with fuel oil. These tests have given great satisfaction in regard to regularity of burn and ease of control. It would even seem possible with large kilns to realize an economy. In little test kilns the cost is particularly the same, at the present price of fuel oil, as with coal.

Ceramic Research

Ceramic research is now placed under the direction of an organization (l'Institut de la Céramique Francaise) aided by the workmen's agreement and a budget given by the state, has just entered upon its activities. It is occupied in developing the study of ceramics and aiding the industries by means of a research laboratory.

The study is divided between two schools. The School of Ceramics annexed to the Manufacture of Sèvres passed under its control and is the highest school of ceramics designed to make engineers. The school installed at Vierzon is designed to make foremen.

The regional schools are simply to inform special workmen.

The experimental laboratories created by the Manufacture Nationale de Sèvres enters equally in the fame of the Ceramic Institute. Its installation will make it possible to carry on researches under good conditions and admit workers who wish to study industrial problems. The city of Paris had an École des Beaux Arts applied to industries with a ceramic section.

Publications Concerning Ceramics

Lefevre, *La Céramique du Batiment*, 1897.
Larchevêque, *Fabrication industrielle de la porcelaine*, 1898.
Bourry, *Traité des Industries Céramiques*.

Granger, *La Céramique industrielle*, 1907
Matériaux et Produits réfractaires, 1910.
Pierres et Matériaux artificiels de construction, 1908.
Le Chatelier, *La Silice et les silicates*, 1914.

There are no publications in France especially devoted to ceramics. The two journals which are the organs of the two groups publish the technical articles. *La Céramique* is the organ of the Syndicate des Fabricants de Produits Céramiques de France. *La Céramique et la Verrerie* is the organ of the La Céramique et La Verrerie.

The Society, as an encouragement to these national industries, has published a certain number of memoirs which were gathered together in 1906 in a volume containing such articles as La Ville, geological studies of clays of France; Le Vezard, contribution on clay beds of France; Vogt, on the composition of clays and china porcelains; Le Chatelier, researches on quartz; Damour Coupeau, Chantepie, three papers on expansion of paste and covers; Granger, tungsten blue, and ceramics in Germany. And in the Bulletin of the same Society, Granger on soft porcelain, artificial or frit, 1913, and Cones, Fusible Cones and Seger Cones (1916).

A workman of Vierzon, M. Larchvêque is particularly interested in perfecting the production of porcelain. To him we owe interesting research in casting. He has published several reports of his work on raw materials used in the production of porcelain.

At the Manufacture de Sèvres they effected during the War notably important works on stoneware designed for chemical use. The Factory contributed its part in the National defense in making not the common pieces (those were in the domain of private industries), but the pieces difficult to attain with the resources at hand.

Its research laboratory has installed a control service for the French ceramic industries, but it has for its particular duty the direction of the workmen in the solution of technical problems.

PARIS, FRANCE

THE DEVELOPMENT OF CERAMIC TECHNOLOGY AND SCIENCE IN JAPAN

BY SEIJI KONDO

Early Ceramic Technology

The ceramic technology of modern times in Japan developed remarkedly in the Meiji period, *i. e.*, 1868–1912. This country, in 1912, entered into friendly relations with other countries for the first time, and accordingly foreign technologies and new industries came to the Empire. However, the sound development of the imported technologies and industries has been chiefly in the past twenty-five years. During the Meiji period, most ceramists endeavored to imitate foreign processes. Of course,

technological and scientific researches were done in some organizations of the government and in other laboratories. The stoppage of import of various materials and goods due to the War caused great consternation among the people and the time came then to awake. Several research organizations and laboratories have since been established for ceramic industries. People are now hoping that Japanese scientists and experts shall hereafter develop the ceramic technology by themselves.

1. Japanese Ceramic Society (Dai-Nippon Yogio Kiokai)

The Society was founded on Oct. 10, 1891, by the graduates, professors and students of the Tokio Higher Technical School, with the purpose of advancing ceramic arts and of uniting ceramic people in the country. It is one of our prides that we have long used the term "Yogio" which means "industries using kiln" or ceramic industries as recently defined by the AMERICAN CERAMIC SOCIETY.

The present members include the graduates of ceramic schools, capitalists, dealers and those who are connected or interested with the industries. The meaning of "Kiokai" is association and not society as it is usually employed, but it is substantially changing to a true society, as almost all graduates of ceramic schools are joining it. Although the society was established by only thirty-seven members, it has now about fourteen hundred.

The Society has been pretty active during the past thirty years, thus: (1) It has published a monthly Journal for thirty years; (2) It has published many books which comprise "The Modern History of Japanese Ceramic Industries" of about three thousand pages; (3) It has held two great ceramic exhibitions in Tokio and (4) Lecture-meetings were held every year by its head-office in Tokio or its branches at Kioto, Osaka and Nagoya.

The present officers comprise of a president (Vice-Count Kentaro Kaneko), eighteen negotiators, twenty standing committees, three directors (Mr. J. Kumazawa, Mr. O. Umeda and Mr. T. Kuranashi), fifty-three councillors, two auditors, two secretaries, two treasurers and two editors.

It owes much to the late Dr. Jintaro Takayama, former general secretary, that the Society could develop to the present state. He is also one of those who has contributed most to the promotion of ceramic technology and science in Japan.

2. Research Organizations and Industrial Laboratories

The Department of Agriculture and Commerce has three ceramic laboratories, *i. e.*, the Third Department of Tokio and Osaka Industrial Laboratories and the Pottery Laboratory in Kioto. The Third Depart-

ment of the Tokio Industrial Laboratory which was founded in 1906 has served much in advancing ceramic technology. The others were established a few years ago.

There are six ceramic laboratories belonging to the local authorities. The Ceramic Experimental Works of the South Manchurian R. R. Co. at Dairen has served much in the utilization and development of the local mineral resources, and they have been very successful, *e. g.*, (1) they found magnesite, fire clays, quartzite, etc., (2) they have manufactured very fine glasswares and (3) they have manufactured porcelains and very good refractory bricks.

Besides, many companies have laboratories, of which the research laboratories of the Tokio Electric Co., the Asahi Glass Co. and the Onoda Cement Co. are most noted.

3. Educational Institutions

The Ceramic Department of the Tokio Higher Technical School is closely related with the development of the technology of Japan. The Department was organized by the late Dr. G. Wagner in 1881 and has long been sole organization for ceramic higher education. It has sent 317 graduates to the Oriental ceramic world, of which 31 are Chinese, and 42 of other nationalities who have completed special courses. The latter includes ten Indians, Philippinos and other foreigners. These some four hundred persons are playing most important rôles in far-Eastern ceramic fields. At present, the Department is educating 61 regular students, including 11 Chinese, and one special student. Besides, its laboratory has contributed much to the promotion of ceramic technology and science of the country.

Among other institutions the following are well equipped and are training experts: The Keijo Technical Special School, the Kioto Pottery Training-School, the Ceramic School of the Aichi Prefecture, the Arita Technical School, the Technical School of the Ishikawa Prefecture, Pottery School of the Gifu Prefecture and the Technical School of the Fukushima Prefecture. We have six other similar schools. The Departments of Engineering Chemistry of the Tokio, Kioto, Kiushu and Tohoku Imperial Universities are also giving lectures on ceramic engineering.

4. The Development of Ceramic Technology

Heavy Clay Products.—The industry of common brick in Japan arose about fifty years ago. Machines, driers and kilns were imported or built early by German experts and many big plants have been erected especially near Tokio and Osaka. Numerous small plants have also been working even in the vicinity of Tokio and Osaka, most of them using "Nobori-

gama" which is a semi-continuous kiln built on a slope. But these small plants have recently been absorbed or displaced almost entirely by big ones. As an example of well-equipped plants, I will describe a plant of the Nippon Brick Manufacturing Company, Tokio: They have there automatic proportioning and feeding apparatus, Cohr's driers improved by their experts, Keller's driers, Ring kilns and Haedrich's chamber kiln. The Osaka Ceramic Industries Co. has seventeen ring kilns.

We have a special face-brick whose surfaces are nearly melted by direct wood-fire and accord well with Japanese taste. A continuous kiln has been patented for massive production. The Osaka Ceramic Industries Company are manufacturing similar bricks by salt-glazing. Rough-surfaced bricks are now prevailing.

The sand-lime brick industry has not yet been successful in Japan; but slag bricks are made on a large scale at the iron works of the Government.

Small tiles, usually $4^{9}/_{32}$" long, $2^{3}/_{8}$" wide and about $^{3}/_{8}$" thick, are most important materials for facing buildings and are used even for decorating wooden buildings. Accordingly, the demand for ordinary face brick has rapidly decreased in the past ten years. The tiles are usually stoneware or hard faience and rather rarely porcelain. Recently, the demand for wall tiles and floor tiles has rapidly increased.

Ordinary roofing tiles are burned in up-draft kilns called "Kawara-Gama." Pine-branches are usually fed into the fire-boxes at the end of firing and every opening is sealed to develop grey color and silver-luster on the surface. Although many patents have been granted for semi-continuous or continuous kilns which aim at the utilization of waste-heat and larger production, they remain still as one of the most important problems in our ceramic industries. Glazed tiles and fitting tiles are now produced in big plants.

Most of the pipes are made in primitive ways. However, several factories have been using screw pipe-presses. A plant with an American steam-press has just been completed. Hollow tiles are manufactured in several plants.

Refractories.—The manufacture of refractory wares in Japan arose in the early years of Meiji.

We have dark red quartzite which attains its maximum expansion very easily in heating. Its contents in ferric oxide range 1.4–4.8%.

Magnesite refractories have been a popular topic, since the mineral was found in Manchuria in 1913.

Very hard stones, occurring in or together with Roseki, have recently been found to be diaspore. Two typical kinds are:

	Silica	Alumina	Ferric oxide	Lime	Magnesia	Alkalies	Ig. loss
Kanakura diaspore.....	2.84	81.76	1.02	.....	.....	.....	14.36
Mitsuishi diaspore.....	6.37	78.72	0.28	.....	.....	.....	14.52

Recently a refractory clay, containing about 56% alumina, was found at Kochi in the Province of Rikuchu. It was ascertained by Prof. S. Kozu that the mother mineral of the clay contains 36.94% silica, 44.13% alumina, 0.08% magnesia, 0.50% lime, 0.05% titanium dioxide, 18.94% water and trace of phosphoric acid and therefore its chemical formula is $2Al_2O_3$, $3SiO_2$, $5H_2O$. He gave the new mineral a name "Kochite."[1]

Stoneware, White Ware and Porcelain.—The Takayama-Kozan Potteries Co., manufacturers of chemical stonewares, succeeded in making very large vessels and complicated apparatus such as centrifugal fans.

Majolica faience, which was introduced by Mr. K. Hirano to our country and was manufactured at the Tokio Higher Technical School for several years, is now popular.

Mr. H. Matsumura was the pioneer in the manufacture of tablewares of hard faience. Mr. Y. Kitamura devoted several years to the study of the faience and contributed much to its development. The Toyo Toki Co., Kokura, are firing hard faiences in tunnel kilns. They are also the first Japanese manufacturers of high grade sanitary wares.

Porcelain which is a most important clay product in Japan is made of bodies composed of "Gairome" (very plastic kaolin) or "Kibushi" (shale resembling ball clay) together with pegmatite or feldspar and quartz in the Provinces of Mino and Owari, while manufacturers in Hizen, Kaga, Kioto, Aizu and some other districts are using bodies composed chiefly of decomposed liparite or quartz-porphyry. According to a report of the Industrial Laboratory by Dr. Y. Kitamura, the composition of Japanese porcelain is 0.26–0.57 RO, Al_2O_3, 4.68–8.21 SiO_2 which indicates excessive contents of silica or bases and silica. However, the manufacturers of high-grade tablewares such as the Nippon Toki Co., Nagoya, the Nagoya Seitosho, Nagoya, and the Toyo Toki Co., Kokura, are probably using bodies composed of Amakusa (best liparite), kaolin and feldspar of first quality to make up the said defect and their chemical compositions are quite different from the common Japanese porcelains.

Most of Japanese porcelain is fired in wood-fired semi-continuous kilns. The Ceramic Department of the Tokio Higher Technical School built early coal-fired kilns for porcelain and it reported also in 1899 and 1901 the result of a continuous kiln consisting of five chambers. These reports led the manufacturers to the use of coal. Mr. K. Asukai, Mr. S. Momoki and Mr. M. Ezoe rendered great services to Japanese ceramic in-

[1] Koza, Seto and Kinoshita, *Jour. Geol. Soc.*, Tokio, 29, No. 339.

dustry in promoting the art of manufacturing tablewares of first quality.

The Nippon Insulator Co., Nagoya, and the Shofu Industries Co., Kioto, are most distinguished manufacturers of high-tension insulators. Insulators, chemical porcelains and refractory porcelains have long been studied and their qualities have constantly been improved.

Glass and Enamel.—The chief siliceous materials of glass are sand and volcanic tuft.

Soda-ash has long been imported chiefly from England. In 1917, the Asahi Glass Company, manufacturers of window glass, started an ammonia-soda plant.

Among other raw materials, selenium used as decolorizer is highly contained in Japanese sulfide ores and is now recovered from their waste products.

As to pot furnaces, gas-fired recuperative ones have steadily increased, though small furnaces of direct firing are still prevailing. Covered pots and "Japan Pots" like tea-pots are commonly used. Mr. Hirano of Dairen has recently succeeded in melting pure white glasses in open pots. The regenerative tank was introduced in 1889 and the continuous tank in 1906.

Since 1909, the Department of Agriculture and Commerce has imported various machines to lend free to glass manufacturers. Various bottle machines have been imported and invented since 1906, but the introduction of Owens' machines by the Nippon Glass Industry Company caused a heavy blow on their competitors. Two years later, Mr. T. Yamamoto imported several O'Neill's machines and a Lynch machine.

The Asahi Glass Co., established in 1907, were the first Japanese manufacturers who succeeded in the window glass industry. They have installed twenty-four of Lubbers' machines since 1914. The Nichi-Bei Sheet Glass Company started a plant in Kiushu in 1919 where Colburn's machines are used.

The industry of plate glasses arose in 1915 and they are produced by the Kiokuto Glass Industry Company which are connected with the Mississippi Glass Company.

Most of electric bulbs are manufactured by the Tokio Electric Company. They are making Mazda lamps, projectors, shades, fixtures, etc. The research laboratory of the Company has succeeded in manufacturing optical, thermo-electric and simple lamp pyrometers, magnesia refractory tubes and crucibles, optical glass slab and circular disc, Audion, Plitron, pure fused quartz, thermometer glass, etc.

Chemical glasses like Jena wares have been manufactured since ten years ago.

The Naval Arsenal in Tokio started an optical glass factory at the be-

ginning of the War, Mr. R. Shibata as expert, and now several kinds of the glass are manufactured there.

Mr. T. Oi patented in 1916 a process of manufacturing bracelet. It consists mainly in drawing out the gathering which has a core with innumerable bubbles, produced by the addition of sodium bicarbonate to molten glass. A large amount of the goods has since been exported every year.

"Silk Glass" which is made by cementing two layers of thick threads to form a sheet has been manufactured since 1912.

There are many enamel manufacturers in Japan and large wares such as bath-tubs and chemical vessels are manufactured.

Cement.—Portland cement in Japan was manufactured first by the thin slurry process, using slaked lime and river-mud as raw materials. Soon the process was abandoned and the dry method came. Most of plants are now using limestone and clay or shale. In 1903, the Asano Cement Company, largest manufacturers in Japan, patented a process of manufacturing the cement by burning the raw mixture, composed of quick-lime and clay or silicates, in rotary kiln for the purpose of increasing the output of rotary kiln and the mill. Recently, a few plants were erected to utilize the waste lime, produced in the manufacture of ammonium sulphate from calcium cyanamide. Blast-furnace slag is also used in the cement factory of the iron works in Yawata. Several years ago, the Osaka Ceramic Industries Company started a plant of thick slurry process, with limestone and clay as raw materials. As for the grinding machines, the use of compound mills as Compeb is prevailing.

Rotary kiln, first installed by the Asano Cement Company in 1903, has steadily increased in its number and size, now two hundred feet kiln being most usual.

Waste-heat boilers and Cottrell's apparatus are used to utilize the waste-heat or to precipitate dust from rotary kilns and lime kilns in a few plants.

Cement specifications were issued by the Minister of Agriculture and Commerce on Feb. 10, 1905. It was modified on Dec. 10, 1909, and on June 20, 1919, as the quality of the cement has steadily been improved.

I am very sorry that time was too short to describe the development of ceramic technology during past twenty-five years in China. In short, it is now undergoing not a little influence from those in other countries. Many laboratories and educational institutions have recently been founded; for instance, the Provinces of Chihli, Shangton and Kiangsoo have each a Government Laboratory for ceramic industries and the Provinces of Kiangsi and Chenkiang have higher technical schools where ceramic engineering is taught.

ASAKUSA, TOKIO,
JAPAN

RESEARCHES BY ASSOCIATIONS OF USERS AND PRODUCERS OF CERAMIC PRODUCTS

ACTIVITIES OF THE AMERICAN SOCIETY FOR TESTING MATERIALS IN THE FIELD OF CERAMICS

By C. L. Warwick

Secretary-Treasurer, A. S. T. M.

The activities of the American Society for Testing Materials in the field of Ceramics date practically from its organization as a national society in 1902. In the year following was organized the Society's Committee on Brick. There then were organized committees on Sewer Pipe in 1904, Drain Tile in 1911, Refractories in 1914 and Hollow Building Tile in 1915. It will be convenient to discuss the Society's work on Ceramics under these headings.

Brick

The Committee on Brick, now designated Committee C-3, was organized in 1903, and for a period of five or six years made a general study of tests and properties of paving and building brick. In particular during that period the rattler test for paving brick was studied, and a paper by Edward Orton, Jr., was presented in 1905 discussing "The Rattler Test for Paving Brick as a Safe Method of Disclosing the Limit of Permissible Absorption." In 1910 the committee arranged for an extensive investigation of paving brick in which over 2,000 samples of the various kinds of brick were distributed among six testing laboratories. The primary object of the investigation was to study the rattler test and to relate the results of that test to freezing, absorption and porosity tests. The investigation was completed in due course and resulted in the Committee proposing Specifications for Paving Brick in 1913 which have since been adopted as standard.

Having completed the study of paving brick, the Committee then turned its attention to building brick and planned an equally comprehensive investigation. Samples of brick from the various producing centers were secured and tested for compressive strength, transverse strength, absorption and freezing, according to methods outlined by the Committee. These tests were made in the engineering laboratories of various universities and technical schools and served an incidental purpose of stimulating interest in the study and accurate testing of brick. Upon the completion of this investigation and based upon the results, the committee prepared Specifications for Building Brick that have since been adopted as standard. In presenting the specifications the committee included a paper by Edward Orton, Jr., entitled "A Study of the Proposed A. S. T. M. Tentative Specifications for Building Brick and a Correlation of Their

Requirements with Sodium-sulfate Treatment and Actual Freezing."

More recently the Committee has been engaged in the preparation of Specifications for Clay Sewer Brick and has proposed specifications that the Society has accepted as tentative.

In coöperation with the Committee on Road Materials, the Committee on Brick is now engaged in a review and further study of tests and specifications for paving brick.

Some of the men who have been prominently identified with the activities of this committee are Logan Waller Page, as chairman from 1905 until 1910; E. W. Lazell, as secretary from 1905 to 1912; D. E. Douty, as chairman from 1911 to 1912 and secretary in 1913; A. V. Bleininger as chairman from 1913 to 1920; Edward Orton, Jr., as secretary from 1913 to 1920; H. T. Shelley, as chairman in 1921. The present officers of the Committee are T. R. Lawson, chairman, H. T. Shelley, vice-chairman, and W. E. Emley, secretary.

Sewer Pipe

The Committee on Clay and Cement Sewer Pipe, now designated Committee C-4, was organized in 1904. During the first four or five years the Committee conducted an extensive series of tests and divided its activities into three divisions: (1) A study of the demands made upon sewer pipe; (2) development of tests and specifications which will secure the materials and methods of manufacture resulting in pipe that will meet those demands; and (3) development of specifications for laying pipe lines under various conditions. Considerable progress was made in carrying out this program during the next few years, and in 1914 memoranda of Recommendations for Laying Sewer Pipe and Definitions of Terms Relating to Sewer Pipe were submitted to the Society. These have subsequently been adopted as recommended practice and standard, respectively.

In 1916, the Committee presented all the data that it had obtained up to that time on its schedule of investigation, and based upon this study, the Committee in 1917 presented Tentative Specifications for Clay Sewer Pipe, for Cement-Concrete Sewer Pipe, for Required Safe Crushing Strengths of Sewer Pipe to Carry Load from Ditch Filling, and also proposed revised Recommendations for Laying Sewer Pipe. The specifications were revised in subsequent years and are now, with one exception, standards of the Society.

The Committee is now engaged in studies of absorption and hydrostatic pressure test requirements; an accumulation of data and formulation of results affecting the chemical requirements of sewer pipe materials; and in a study of desirable changes in dimensions of sewer pipe and their permissible variations.

Some of the men who have been prominently identified with the activities of the Committee are Rudolph Hering, who has been chairman of the Committee since its organization, A. J. Provost, who has been vice-chairman since 1910, and G. T. Hammond, who has been secretary since 1918. C. F. McKenna served as secretary of the Committee from 1904 until 1910 and E. J. Fort as secretary from 1910 to 1918.

Drain Tile

The Committee on Drain Tile, designated as Committee C-6, was organized in 1911 to meet two very urgent conditions: (1) The comparatively recent development of the extensive use of very large drain tile in public drainage works for reclaiming wet lands, and the consequent unexpected discovery that these large drain tile were quite subject to cracking in the ditch under the weight of the ditch refilling, and (2) the comparatively recent introduction of the use of concrete drain tile on a large scale and the resulting controversy between clay tile and concrete tile producers as to the merits of the new material. Prior to the organization of this Committee there were no standard specifications for drain tile worthy of the name. Engineers had been in the habit of devoting a paragraph to drain tile in sewerage specifications, and drainage engineers had been trying to specify more definitely the qualities of drain tile. The Iowa Engineering Experiment Station had previously been engaged for some four or five years in the investigation of the causes of cracking of large drain tile in ditches, which served as the basis for certain specifications for drain tile and for methods of testing subsequently adopted as standard by the Iowa State Drainage Association, the Iowa State Engineering Society, and others.

The first task of the newly organized Committee was to plan and conduct an extensive series of investigations covering methods of tests, the determination of desired quality and durability of drain tile, and a study of methods of manufacture and construction and field specifications. In this work the Committee was assisted by a number of engineering laboratories and by the manufacturers of both clay and concrete tile. These investigations, which extended over five years—from 1911 to 1916—are estimated to have cost over $25,000.

In 1914, Committee C-6 prepared tentative Specifications for Drain Tile covering strength tests, quality, and requirements for strength of tile as used in ditches. These specifications were submitted and adopted with the understanding that they were not complete, particularly with regard to the requirements for absorption tests and freezing and thawing tests of tile. The specifications were adopted as standard in 1916.

Following the adoption of the specifications the Committee continued

an investigation of freezing and thawing tests, which resulted in an important modification of these requirements in 1921.

The Committee is at present engaged upon an investigation of chemical tests and chemical test requirements for drain tile to determine their resistance to the action of alkalies and acids in soils. The Committee is also studying the reduction of the number of standard sizes of tile, believing that the adoption of reduced number of sizes would cause and bring about a large saving in equipment, stock on hand, interest on investment on stock and plant and the cost of changing machinery in the manufacturing of the various sizes.

Some of the men who have been prominently identified with the activities of the Committee are Prof. Anson Marston, who has served as chairman since the organization of the Committee, and Mr. J. T. Stewart, secretary from 1911 until 1921. The present officers of the Committee are Anson Marston, chairman; G. W. Pickels, secretary; D. A. Abrams, assistant secretary.

Refractories

The Committee on Refractories, now designated as C-8, was organized in 1914. The Committee devoted the first three years to a general study of methods of testing refractories and in 1917 recommended proposed Tentative Methods for Ultimate Chemical Analysis of Refractory Materials, proposed Tentative Test for Refractory Materials under Load at High Temperatures, and proposed Tentative Test for Slagging Action of Refractory Materials. In the following year the Committee recommended a Tentative Method for Porosity and Permanent Volume Changes in Refractory Materials, and in the following year a Tentative Method for Determination of Softening Point of Fire Clay Brick and Tentative Definitions for Clay Refractories. The purpose of these definitions, which relate to the resistance to heat and constancy of volume of clay refractories, is to classify refractories into the following four groups: High heat duty brick, intermediate heat duty brick, moderate heat duty brick, and low heat duty brick.

In 1920 the Committee proposed Methods of Analysis Covering Chrome Ore and Chrome Brick, and in 1921 Methods of Test for Resistance of Fire Clay Brick to Spalling Action were proposed. All of the methods and definitions above mentioned have been adopted as standard save those for Slagging Action and Resistance to Spalling Action, which are still tentative. The reports of the Committee during these years have contained results of a number of important investigations, among them one on the "Slagging Action of Refractory Brick," by Messrs. C. E. Nesbitt and M. L. Bell; a paper by R. M. Howe entitled "Vital Factors in the Testing of Fire-Clay Refractories," and a paper by W. A. Hull on the

"Status of Thermal Conductivity in Specifications for Refractories;" and in 1922 a report on Precision and Tolerances as applied to the various methods of test prepared by the Committee.

The work of the Committee on development of test methods represents but one side of its activities. As a preliminary step to the preparation of specifications for refractories the Committee has planned a survey of the requirements for refractories in the various industries, which it is necessary to undertake for each specific industry before it is deemed possible to write acceptable specifications for use in that industry. Pending the development of this side of its work the committee is continuing the study of test methods.

Some of the men who have been prominently identified with the committee are A. V. Bleininger, as chairman from 1914 until 1921; C. W. Kanolt as secretary from 1914 to 1916; W. H. Fulweiler, secretary from 1916. The present officers of the Committee are R. C. Purdy, chairman, W. H. Fulweiler, secretary.

Hollow Building Tile

The Committee on Hollow Building Tile, designated as Committee C-10, was organized in 1915. The Committee planned an investigation of clay hollow building tile and reported upon the scope of the work and the investigations under way in 1917. The results of compression and absorption tests and tests of tile walls were presented to the Society that year. Tentative Specifications for Clay Hollow Building Tile and Definitions of Terms Relating to Hollow Building Tile were submitted in 1921. Both of these are still in the tentative stage. The Committee is continuing its investigations in studying the physical properties of hollow building tile with special reference to their fire resistance. Data obtained in this investigation will undoubtedly greatly influence the future development of specifications and tests for building tile.

Some of the men who have been prominently identified with the activities of the Committee are L. H. Provine, as chairman, and E. V. Johnson, as secretary, from 1915 to 1920; W. A. Hull, as chairman, and C. C. Crockett, as secretary, from 1920 until the present time.

Conclusion

The investigations of these five Committees undoubtedly have stimulated research and investigation in their respective fields. Not only do the reports of the Committees contain much information of value in addition to the specifications and methods of test that were prepared, but the *Proceedings* of the Society also contain many papers dealing with clay products that have served materially to advance our knowledge of them.

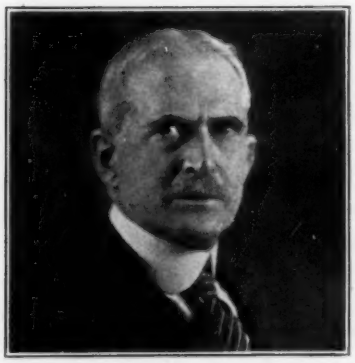
PHILADELPHIA, PA.

THE INFLUENCE AND ACHIEVEMENTS OF THE NATIONAL BRICK MANUFACTURERS' ASSOCIATION ALONG TECHNICAL LINES

By Theodore A. Randall

The National Brick Manufacturers' Association was the first organization created in the United States to offer a forum for the discussion of manufacturing and technical problems on a national basis, drawing information from all parts of the country. Through its conventions and its published papers it created the nucleus of a technical literature. Its membership comprised the most intelligent and progressive men of the structural clay industries, men of extraordinary high qualities. The N. B. M. A. attracted also technically trained men like Orton, Lovejoy, Richardson, Wheeler and others who were glad to participate in its work.

The pioneer instinct of the country, the love of new business ventures, the cheerful undertaking of unknown risks, the sturdy independence of the small brick and tile maker, real good fellowship and hearty good will—all found expression in this Association. It therefore has a real history which is as much part of the industrial and technical development of the country as the latest contributions on technical subjects.



Thomas E. Wilson, Pres. N.B.M.A.

Many of the original papers must still be referred to if a correct impression on certain topics is to be obtained. Attention is called to the work of Lovejoy on the dehydration of clay; that of Richardson on the dry press process and brick-making in general; that of Wheeler on the paving brick materials; the earliest work of Orton on the brick rattler and numerous other activities, chief among which was the establishment of the School for Clayworkers at the Ohio State University.

The initiative in this great pioneer enterprise was taken by a committee of the N. B. M. A. composed of D. V. Purington, W. D. Gates, W. D. Richardson and Theo. A. Randall. These gentlemen journeyed to Columbus on an invitation by Prof. Orton and had a conference with the University faculty. Each in turn was introduced by Prof. Orton and spoke briefly of the necessity for better technical education for clay workers. The University directors were so favorably impressed, Prof. Orton was authorized to add the branch of ceramics to the college course. From that initiative effort, by the representatives of the N. B. M. A., have grown the various schools and institutions of technical learning in ceramics in America.

As previously stated when Prof. Orton, Jr., first proposed the establish-

ment of a school of clay working at Columbus, the N. B. M. A. strongly supported him and it has always since consistently supported other schools and institutions which are for the advancement of the art. Primarily, it has always stood for technical progress by giving a hearing to the machine manufacturers, the brick and tile maker and the exponent of scientific knowledge. The knowledge of its membership may not always have been technical, but it represented actual experience, cheerfully and gladly offered, without which all theory is in vain.

After the establishment of the Ceramic Department at the Ohio State University, its Director, Prof. Edward Orton, Jr., became still more closely associated with the N. B. M. A. and in coöperation with Professors Talbot and Hatt completed the first standardization of the rattling machine for the testing of paving brick. The Association then established a scholarship at Professor Orton's institution, a position filled in succession by a number of students, who later made names for themselves in the industrial and academic world.

The first holder of the scholarship was Albert V. Bleininger, followed by Ross C. Purdy, C. H. Griffin, Homer F. Staley, A. P. Potts and others. In the course of the work of the N. B. M. A. scholarship at the Ohio State University a number of investigations were conducted on the effect of the brick structure with reference to the rattler test, the effect of carbon and sulphur on the burning process, the drying of clay, etc.

Prof. Orton gave this his closest attention and the result was that from it resulted probably the masterpiece of all his subsequent researches, that well known classic, his investigation on the Oxidation of Carbon in Clays. It would be difficult to compute the value of the results of this study to the clay industries of the country and the world, but it must be many, many millions of dollars. Through the rules for governing the burning process as laid down by Prof. Orton, fortunes have been saved and the firing of clay products reduced to a rational basis. This work of Prof. Orton's, though the result of his own genius, still was done under the auspices of the N. B. M. A., and it is a source of no little pride to its membership to be able to enjoy this reflected glory.

Finally, with the growing interest in technical ceramics a number of our members were active in the founding of the AMERICAN CERAMIC SOCIETY, following the meeting at Pittsburgh in 1898, among whom were Prof. Edward Orton, Jr., W. D. Richardson, Ellis Lovejoy, Prof. H. A. Wheeler and A. V. Bleininger.

The technical work of the Association has always been kept in the foreground as much as conditions would permit. Many descriptions of plants or new processes are recorded in its *Transactions* and numerous reports have been issued on technical matters contributed by the Federal Bureaus, principally the Bureau of Standards. Among the really big things

which have been accomplished is the coöperative work with the latter Bureau on the testing of large size brick piers, probably the most extensive work along this line ever done anywhere in the world.

Many other reports on technical subjects have appeared in our transactions from architects, engineers and geologists and the members of our ceramic faculties. As a whole then, the history of the National Brick Manufacturers' Association is that of a technical organization, imparting to its membership technical information in plain terms and seeking to place its business on ever higher levels. Its Committee on Technical Investigations, though sadly handicapped by lack of funds, has kept the spark of research alive.

INDUSTRIAL DEVELOPMENTS

If scientific research is of value, what has it done for the ceramic industries? Have changes in conditions or methods resulted from the past twenty-five years of ceramic research and education? Such questions as these are not evidences of doubt; they are signs of a willingness to stand for a searching analysis of the situation.

Ceramic concerns are today searching for trained ceramic engineers to superintend and manage plants, and particularly to have in charge plant control. This is true in enamel, glass, brick, tile, refractories, terra cotta, pottery, and indeed in all ceramic lines. In contrast to this present demand for trained ceramic engineers, there was very little tolerance for them twenty-five years ago.

Increased production and increased wage cost, more than any other factors, have brought the necessity for supplanting hand labor for machine methods. These two factors have forced a change from dependency on the bigoted "experts" and skilled artisans, with their limited stock of secret knowledge, to charted organizations, control records, and an appreciation of the value of exchanging information. The ceramic industries are rapidly acquiring freedom from dependence on special knowledge and skill of an individual, and are requiring to an increasing extent that their directing employees shall have sound technical judgment and leadership based on ability to learn and to marshall the fundamental scientific and engineering facts to the solution of manufacturing problems.

It is true that there were several individuals twenty-five years ago who could produce a certain ceramic object of most excellent quality, but such individuals rarely succeeded in producing on a quantity basis. Such "experts" are not regarded so highly today, and in their place are the ceramists of broad training in the fundamentals of the sciences and engineering, or of science and art as applied to ceramics in general. Organized collaboration has displaced individual "experts."

A ceramist broadly trained and of excellent executive ability cannot alone meet the requirements of present day manufacturing. He is dependent upon the equipment manufacturers, the producers of materials, the research men in universities, bureaus and institutes, and upon the equipment, material and research men in allied industries. It is through collaboration and exchange with scientists and technically trained industrialists generally that our ceramists have the ability to replace the erstwhile "expert." Success in manufacturing is not now built upon the secrets possessed by an individual, but upon an organization that keeps in touch with the developments in science, engineering and art generally, and has the knack of making industrial applications of the things learned.

The improved machinery, kilns, dryers, and, in fact, all factory improvements result from adaptation of the findings of many contemporaneously working scientists, engineers, and artisans. No ceramic manufacturer can in truth say that no advantage has accrued to him from the vast investments of time, money and energy in fundamental and applied researches which have been made, and which are, on a much larger scale, being made today.

The promptness with which the ceramists produced a spark plug which would successfuly meet the severe requirements in aeroplane motors, and the promptness with which the collaborating scientists and ceramists produced excellent quality optical glass during the recent War, are not without parallel in achievements of ceramists in other lines.

There is no art or skill in potting or in brick making ever known that is "lost" to the present day ceramist. They have maintained standard quality in *all* ceramic products and have made great improvements in quality in many. This, in spite of the supplanting of the low production of the hand methods of the highly skilled artisans by high production of machine methods with only average labor skill, is one of the benefits to the industries from researches and from exchanges through associations of scientific and technical knowledge.

A recital of some of the advantages which have accrued to the ceramic industries is given on the following pages.

ARTISTIC GLASSWARE

By Frederick Carder

One cannot review the advances made in blown artistic glass in this country during the past twenty-five years without looking backward a few more years.

It was in the early eighties that a renaissance of the glass industry commenced in the English speaking countries. The 1851 Exhibition held in London gave the necessary impetus to the revival of this most fascinating art, and to such men as Benjamin Richardson, Wilkes Webb and John Northwood, is this principally due.

Benjamin Richardson gathered around him young men whom he inspired with a love of their craft, whether in making, cutting or painting, and later etching which was then a new type of decoration.

John Northwood was a pioneer in this art, designing and developing numerous machines and processes. After designing and carving a vase with a copy of the Elgin frieze in relief as a principal motif, he conceived the idea of duplicating the Portland vase in glass, the same size and color as the original in the British Museum. This he successfully accomplished

after many failures. He was the first to polish cut and engraved glass by the use of hydrofluoric acid.

This carved or sculptured glass was taken up by Wilkes Webb who gave it a great amount of thought and energy, placing it successfully before the public.

Artists of other countries were not slow to avail themselves of this new art craft, and chief among them stand out Émile Gallé and Daum Freres of Nancy.

The works of these men raised the glass industry to a higher level in their own country as well as abroad.

About 1883 colored glass articles made entirely at the fire began to make their appearance. Investigations in colored glasses were conducted in England from 1883 up to 1900 by the aid of a Fletcher Gas Furnace of the same type that Abbe & Shott of Jena used for their investigations in optical glasses about the same time.

Mention should also be made of the pioneer work of Harry Powell of London who not only made some exquisite work in thin blown glass in delicate shades of color, but who made the glass mosaics to the designs of Sir W. B. Richmond for Saint Paul's Cathedral. Up to this time glass for mosaics was only made in Venice.

From 1883 up to the present time, a gradual progress can be discerned.

During this period cut glass was slowly being manufactured in this country by imported artisans and with imported European blanks. Later, as fine sands were discovered in the United States, manufacturers began to make their own blanks and ultimately were able to beat the European product in point of crystal clearness and color, owing chiefly to the sands found in the United States being almost free from iron oxide.

The American Ceramic Society was hailed by the glass manufacturers of ability as a means of obtaining technical knowledge, and the improvements made in the ceramic industry were reflected in the sister art.

The introduction and use of the Siemens Regenerative Furnace made possible more constant and dependable temperatures, together with the discovery by Le Chatelier of the platinum pyrometer.

The invention also of the oil and gas glory hole or re-heating furnace was an important step. This enabled the workman to obtain quicker heats and to work with greater facility than was possible in the pot with its numerous interruptions of men gathering glass out of the same pot. The furnace is now only used to melt the glass.

The most important artistic advance in this country at this time was made by John La Farge in his opaline glass. Examples of his church windows made from this beautiful material were exhibited at the Paris Exhibition in 1889. Following this was the invention of Favrile glass, the product of the Tiffany furnaces, and later, Aurene glass made by another

firm. This glass was a distinct advance from an artistic as well as from a chemical point of view, emulating the gorgeous effects of ancient glass which through decay or devitrification produced colors of prismatic hues. These effects of coloring are now obtained at the fire by the aid of the oil and gas glory hole which were impossible before.

The decorations are chiefly of superimposed glass either in threads or dabs, wrought while hot into a great variety of patterns and emphasized by the beautiful play of iridescent colors, obtained by the reduction of the rare metals dissolved into the mass. Such effects rival the peacock in their metallic sheen.

The cut glass industry became one of considerable importance and the products were highly thought of by the public. In fact American cut glass was considered in Europe of particular excellence.

It gave employment to a large number of artisans, until some years ago, a few manufacturers, influenced no doubt, by the American cry of production, decided to make cut glass on a ton basis, by what is known as pressed figured blanks, where the patterns are pressed or stamped upon the article, and then cut over.

This machine idea of making artistic glass (that is if cut glass can be claimed as such), was the means of putting it out of fashion, and removing it from the pedestal it formerly occupied in the public estimation.

The name rock crystal for polished engraved work, was given about 1883 to work of this character by some English manufacturers who were influenced by the fine collections of real rock crystal in the Louvre and other museums. Beautiful work of the engraver's art in table glass has been turned out by English factories. As the best and finest of these came to this country, it naturally gave a stimulus to our manufacturers to work also in the material, some of their products being of high order.

Intaglio or stone engraving was the next step, the designs being bolder and not so delicate as the engraving with the copper wheel.

Coincident with the growth of electric lighting in the United States and the adoption of high candle power lamps, a decided improvement was made in glassware for shades and bowls. These shades were made in soft colors with the decorations applied at the fire, giving a very pleasing effect when used to shield the excessive brightness of the electric light. These had a considerable vogue until some manufacturers made cheap imitations in paint which were sometimes fired but many of them merely dried.

Later came the semi-indirect bowl made first in alabaster glass, the revival of a glass that was used about 1851 for vases. Many of these bowls, although made in pressed glass, were artistic in design but cold in color. This was followed later by using glasses of softer and warmer tones which gave better and more artistic results, especially so, as more attention was given to the designs.

Lighting goods of this character obtained an excellence in this country far surpassing the products of Europe.

Just before the War, owing to cut glass going out of fashion, a return to Venetian glass was made with its wealth of color and form, together with its appropriateness in fitting in with home surroundings.

There had been, however, a small amount of similar glass made by one factory in the United States for some years prior to this date. It gave them an opportunity that they had long hoped for. The results were that a distinctly new type of artistic colored glass was designed, that was taken up by the public with enthusiasm.

Other factories have since turned their attention to the making of colored glass, one or two making a good product, while others are making it cheap and hasty—this latter tendency on the part of some American glass manufacturers is deplorable, and, as in the case of cut glass some years ago, can mean only one thing, *ruin to the industry.*

As Ruskin said, "A disposition for cheapness and not for excellence of workmanship, is the most frequent and certain cause of decay and destruction of arts and manufactures."

Let us hope that the American manufacturers will look to it that this beautiful art craft is fostered and encouraged.

CORNING GLASS WORKS
CORNING, NEW YORK

THE INFLUENCE OF THE AMERICAN CERAMIC SOCIETY IN THE TERRA COTTA INDUSTRY

BY W. D. GATES

In bringing team work into the industry, this SOCIETY has done a wonderful work for the terra cotta interests, as well as those of all the other divisions. Until its formation there had been too much secrecy and the work and research was individual. Each man had to attack the whole wide field and his time was so short and the field was so broad that it was impossible for individual effort to accomplish much. By the broadcasting of experimental work, that has come about from this SOCIETY, each man profits from the work of each of the others, is helped by them and in return helps them, and in this way a wealth of information is obtained and distributed. In the past, if a man made progress in the art, or made an important discovery, it was locked in secrecy and either perished with him or passed into the hands of someone incompetent to put into it the vim necessary to its successful development and use. There was no literature for the art. What discoveries were made were soon lost and there were long lapses when the art seemed dead until revived by some strong character, only to lapse again and die out. This SOCIETY built up among its

members appreciation and love of their art as the supreme achievement, placing the good of the art above their individual interest, thus making it permanent and lasting, a perpetuated and lasting art, to be used and built up constantly by future generations by giving them the results of our experience on which they might build up still greater achievements.

This has also resulted in the education of the public to their realizing that ours was indeed an art, that in its upbuilding we were using skill of a high degree, scientific attainment equal to or surpassing other arts, and an enthusiasm unequalled elsewhere. They are coming to realize that we are taking an inert, commonly distributed material, and are impressing on it our individuality, the very best that is in us, and doing it earnestly and enthusiastically. We are impressing on an imperishable material the results we have acquired from this SOCIETY, earnestly studied out and used enthusiastically, joyful in our work, glorying in it, so that what we have wrought into it will not only be a joy to people now living but will be passed on from generation to generation.

Half a century ago men in Italy were digging clay, selecting, experimenting, enameling and burning, and Della Robbia, seeing its possibilities, took what they had and wrought into it his visions and conceptions and thus left a priceless treasure to the world. Other clay like it still remains unused today, but because of the good work of the diggers, the mixers, the enamelers and burners, topped with Della Robbia having taken the results of all their skill and then impressed into it his personality, the very best that was in him, his visions and conceptions, the world has been, and will be for all time, richer and better.

CHICAGO, ILLINOIS

THE ROOKWOOD POTTERY COMPANY

BY STANLEY G. BURT

The desire to develop a distinctly American pottery led Mrs. Maria Longworth Storer to found the Rookwood Pottery in 1880. Her aim from the start was to get rich warm colors. The great desire of the pottery artist at that time was a white body, then an overglaze decoration as perfect as possible, but one that must never entirely conceal this so desirable white body. As a distinct innovation Rookwood started with a colored body, yellow, red or blue-grey, and on this colored clay before it was burned painted with a great variety of colored slips. The pieces after being fired were dipped in glaze making the decoration underglaze work, not overglaze as commonly practiced.

When the method of atomizing these colored slips was discovered at Rookwood a new field was opened. Instead of the artist being confined to the color of the clay for background any color desired or various colors

could be atomized over the whole piece. This lead to the colored clays for the body being abandoned. The finest rich colors were not obtained, however, until a new glaze colored yellow was used in place of the older clear colorless one. This perfected Standard Ware was so amazing to the judges at the Paris Exhibition of 1889 that they asked to have more ware sent over to prove it was not an accident.

While the Standard Ware used mainly browns and reds a new type was next made called Iris for which the artist chose cooler colors and a rich black, the glaze in this case being without color.

In 1896 Rookwood made its first matt glazes and at the Buffalo Exposition of 1901 not only showed a wide range of colored matt glazes but vases painted by its artists using these colored matt glazes as an inlay. Nothing at all like these pieces had ever been made before. As a matt glaze is ordinarily opaque all underglaze decoration was concealed. The years of experience in underglaze slip painting were too valuable to lose so the Rookwood vellum glaze was next developed and shown at the St. Louis Exposition in 1903. It was said to be the only ceramic novelty there. With this glaze the artists were able to return to slip painting on the wet clay. This was fired as usual and then given a dip of vellum glaze and fired again. These pieces came from the kiln with the matt surface desired and with all the decoration easily seen through the glaze.

For the perfect development of these matt glazes a most carefully controlled fire was necessary. As Rookwood was probably the first American factory to use Seger cones, starting in 1895, and as the electric pyrometer was also in use at that time these with oil for fuel made it possible to have very accurate firing.

With the matt glazes perfected Rookwood started its Architectural Faience department. Here the main idea might be called mural decoration. Bright glazes on large flat surfaces are objectionable owing to surface reflections. This the matt glazes entirely avoid. A very interesting field is offered here for the artist, a large wall to be decorated presenting new problems in sharp contrast to those presented by vase decoration. In decorating the faience the artist paints with colored glazes instead of with colored slips.

At present while a great variety of matt glazes differing in texture and color are made on vases not painted by artists, the painted ware shows a partial return from matt to the bright glazes. This ware is called Soft Porcelain. The body used is new but the chief study has been in the choice of glazes. The colored grounds always used at Rookwood before are often lacking, the inspiration coming largely from the old Chinese porcelains.

Rookwood was the first to use crystalline glazes for pottery decoration. The Tiger Eye shown at Paris in 1889 has its crystals deep in the glaze

and not more on the surface as shown by those which appeared later from other factories.

Rookwood has received many honors and among these Gold Medal, Paris, 1889; Highest Awards, Chicago, 1893; Grand Prize, Paris, 1900; St. Petersburg, 1901 and Turin, 1902; two Grand Prizes, St. Louis, 1904.

ROOKWOOD POTTERY CO.
CINCINNATI, OHIO

SOME EARLY EXPERIENCES IN ENAMELING CAST IRON

BY E. S. DAWES

So far as the early history of the enameling industry is concerned, I know but little outside of the sanitary line, and do not know if I can give any information of interest to the SOCIETY. My knowledge began just forty-four years ago this month. At that time the J. L. Mott Iron Works were the only people in this country who made any pretense to make enameled sanitary ware, and I do not know if they had aspired to a bath tub as early as that.

But in 1879 the Standard Mfg. Co., in whose employ I was, first as a bookkeeper, and after as manager, made one to two cast iron tubs per day. We had but one style that was known then as the "Prison" tub. They were too cold for comfort, etc. Of the two tubs per day, there were but few enameled; the greater part of the production being painted and galvanized.

The old River Avenue property in Allegheny (now Pittsburgh) was built about 1870 by Ahlborn, Hartje, Wiley & Co., who made enameled stove (cast iron) hollow-ware. They failed in the panic of 1873 and in 1875 the property was bought at sheriff's sale by the late James W. Arrott and Francis Torrance and operated as the Standard Manufacturing Company. Mr. Arrott was father of the Arrotts who now own and run the U. S. Sanitary Mfg. Co., and Mr. Torrance was father of the late Francis J. Torrance.

The Standard's business was about 95% enameled stove hollow-ware, the other 5% consisted in 3% miscellaneous castings, and about 2% in the plumbing industry—mostly in a couple of patterns of water closet hoppers and wash stands for factory use. But few of these were enameled, the majority being painted.

Up until this time there was but little known as to the making of enamel outside of a very soft leadless enamel for cooking utensils. But about 1879 the wood pump industry took on a boom, and created a large demand for enameled iron cylinders. This business was divided practically between a small enameling concern, a split from Ahlborn, Hartje, Wiley & Co., at the time of their failure, and the "Standard," and it was soon learned

that in the soft glass used in the hollow-ware industry, the soluble constituents in the enamel or glass dissolved and the enamel became so rough that it would wear out the leather suckers. This was about the first time there was a necessity to put some thought into the why's and wherefore's of the ingredients to make a non-soluble mixture and it was the first effort on our part to eliminate the soluble fluxes and incorporate insoluble ones.

This pump cylinder business flourished for several years until drawn brass tubing took the place of the enameled cylinders. Now, with the loss of this business it was necessary to find something to take its place, and this was the time and opportunity to embark in the manufacture of enameled plumbing goods. About 1883 or 1884, the Standard added to their line several styles of lavatories, water closet hoppers and one pattern of bath tub. This was made in what was then known as the French pattern, and the design followed closely the pattern or design of the old copper tub. It was made with a hard-wood rim fastened on with wood screws and the molder who could make such a tub was considered very skilful. We (the Standard) started an aggressive campaign to make a business out of the plumbing industry. To encourage the jobbing trade we guaranteed stocks in warehouses against defects, damage, price, etc.

In embarking in the manufacture of tubs and other plumbers' ware, it was necessary to discontinue the use of the hollow-ware enamel and to make enamel that was white and flexible enough. The cylinder and hollow-ware enamels were blended. Up to this time what ware had been made by the Mott Iron Works was first coated with a very soft and porous coat, known as bone coat, that was so porous it took on rust, which showed through the enamel as a discoloration, similar to lime spots. The manner of applying the enamel was by mixing it with alcohol, which would evaporate quickly, and floating it on the ware. This proved a very unsatisfactory process, but as long as the business was limited there was no object in trying other ways.

It was about 1882 or 1883 that August Haarlander, who was the enameling foreman, and the writer commenced experimenting to make an enamel that we could dredge on the article, as is now done and which with improvements and modifications is the method followed today. Even at that time there was but little thought of the ultimate future of the industry. At the time I severed my connections with the Standard Company we had not made more than 10 or 15 tubs per day, and lavatories in proportion.

In 1887 the writer, in company with the late W. A. Myler, who was the accountant of the Standard Mfg. Company from 1881 until 1887, built the plant at New Brighton, Pa., known as the Dawes & Myler Works. Even at this time the growth in the business had been so slow that we started to make enameled stove hollow-ware, and it was not until about 1890 that we put in patterns to make bath tubs. From that date the business

grew rapidly, so rapidly that when in 1893 the New Brighton factory was burned, in rebuilding, the plant was constructed to make enameled sanitary goods exclusively. The demand for enameled baths, lavatories and other sanitary goods having increased to such an extent, it was necessary to find means to increase production and at the same time to reduce costs so that the modern appliances would be in reach of the masses.

The output of the enameling plants of the country prior to 1900 was very small compared to present day production. There were fewer plants and the capacity of each plant was small. The production of bath tubs by the Standard Mfg. Company, which was the largest producer in the world, was 45 tubs per day in 1893 and about 150 per day in 1899. This appears small compared to the present capacity of 2000 tubs per day of the Standard Sanitary Mfg. Company.

Shortly prior to 1900, John C. Reed, who was then manager of the Standard Mfg. Co.'s plant in old Allegheny, now North Side, Pittsburgh, Pa., conceived the idea of making tubs by what is commonly known as the match plate system. The process was new and unique and was patented by him. About the same time James W. Arrott, Jr., patented an automatically actuated dredger. By these two inventions the output was largely increased. Prior to that time a moulder would make two bath tubs per day. By the Reed process four men produced some 36 tubs per day of 8 hours. The automatic dredge added largely to the speed of the output which up to that time was a bath tub per hour or 24 tubs per furnace per day of 24 hours. With this, other improvements were injected into the shops: a mechanically operated table on which the red hot tubs were enameled, with other improvements from time to time, have cut the working force on a furnace one-half. Then the furnaces that could heat only one tub an hour were improved upon from time to time, until at present time 3 to 4 tubs per hour are obtained. While these improvements in way of manufacturing were going on, the management was making improvements in designs. At first the tubs were made with wood rims. From wood the enameled roll rim was evolved—from the tub on feet, the one-piece tub, enameled inside and out, changing the bath room from a room for bathing purposes only into the pride of the house owner. The lavatory with the slab and bowl cast in two pieces and butted together, making an unsanitary and unsightly job, has grown into the beautiful one-piece lavatory of the present day.

While a number of the men who laid the foundation for the large industry of the present day have passed away, the real life of the business is so recent that the ones who were so instrumental in its growth, are still actively engaged in the business. As a finality, what I have passed over is the organization of the Standard Sanitary Mfg. Co. in 1900. At that time the largest producers of enameled sanitary ware in the country were the

Standard Mfg. Co., of Pittsburgh, Pa., the Ahrens & Ott Mfg. Co., of Louisville, Ky., and Dawes & Myler of New Brighton, Pa. At the time of combining to form the Standard Sanitary Mfg. Company they bought up several other concerns, consolidating such equipment as could be used in the three plants. The plants thus bought were scrapped and sold.

From the time of its formation this Company has maintained its position as the largest producer of enameled iron sanitary ware in the world, and has contributed its share to the development of the industry during the past twenty-two years. However, just as we realize that others besides ourselves were instrumental in founding the sanitary enameling industry in this country, just so we are fully aware that other concerns have furthered its later development. We take this occasion to express our appreciation of the ability and energy of our competitors.

2305 Commonwealth Avenue
Chicago, Ill.

EARLY HISTORY OF ENAMELING IN THE VOLLRATH COMPANY

By C. A. W. Vollrath

Enameling, I feel justified in saying, is an intricate art, as the experienced enameler well knows and as the novice is ready to admit. The adhesion of a hard porcelain coating to a metal body of radically different physical characteristics demands the best that science and practice have to offer, and makes the subject one which will always be of interest. Naturally, research work will give beginners a valuable foundation in bringing out many facts well known to older enamelers. On the other hand, and because of the secretive nature of the business, the older enamelers have possession of information pertaining to enamels for certain uses which new men in the field do not have.

During my personal experience in enameling, covering a period of approximately fifty years, so many theories and so much experimental work has been advanced and discarded that to attempt to assemble and enumerate this data would be well-nigh impossible. My experience in the development of porcelain enamels I admit has been unusual and uncommon to many of those now in the field, and had this data but been recorded by me, it would today be productive of data of interest and much interesting reading, but I have never recorded these facts.

Prior to 1874 my father was a foundryman and a manufacturer of steel. It was in 1874 that he first built his plant for the manufacture of cast iron enamel ware, from which time my personal experience more distinctly relates.

In 1867, when I was a youth, I very vividly recall an experiment made by my father in attempting to coat a previously heated cast iron pan with

a molten mass. He so manipulated the pan and mass as to evenly distribute the latter over the surface of the pan, allowing the surplus to run out and subjecting the pan to a reheating. The mass in the mix was red in color, leading me to believe that, no doubt, red lead in quantity had been used. The experiment must have been unsuccessful, since nothing developed from it. My youth prevented me from knowing the full details of this experiment.

It was in 1870, after extended experiments and progress in enameling, that we secured in Europe interesting and valuable formulas. The frit ground coat was not greatly different from that used today, the glaze was softer than those of present origin. Silica, mica, soda, borax, kryolith, potash and saltpetre furnished the minerals and fluxes, with clay on mill for white enamel, and without clay for gray enamel.

At that period ground coats were fritted in muffles, the glaze enamel was melted one, two and three times in clay crucibles, with small holes in the bottom of the crucibles through which the molten mass passed. Four crucibles were usually placed in the melter, and the mix was continually fed into the crucibles

In this period the grinding mills were made of granite, each mill having one runner for wet grinding. Cast iron muffles also were used for burning.

It was in 1880, I believe, that glazes were made with feldspar, silica, borax, kryolith, soda, saltpetre and tin oxide, with clay in the mill for white enamel.

It was about this same period also that vat smelters were used for the glazes, and about this time gas-fired clay-tile muffles for firing the ware were built. About this time one of the first dry pulverizers (pebble mills) made in the United States was installed. The hollow-ware castings were enameled outside as well as inside. A variety of finish coat enamels were made, including speckled enamel. Specks were made by adding oxides of manganese or cobalt in quantity to a mix and grinding dry, and then by adding a certain per cent of this mix to an enamel mass, these specks would appear after firing. This method of producing specks I patented in the year 1889. (This enamel is being produced today by several manufacturers.)

All through these years hollow-ware had been cleaned before coating by milling with broken pieces of iron, or scouring by hand or machine-scoured with sand and water. Pickling cast iron was also a common practice, but the nature of the ground coat produced no end of defective ware when pickling was resorted to in wet process enameling. With recognition of this fact, many have resorted to sandblasting in an attempt to avoid these defects. Bath tubs and sinks at this time were always pickled, ground coated and dry powder applied when heated. Any other method, as wet white ground coat and glaze wet applied, developed an enamel finish of uncertain quality on bath tubs and sinks.

Wet white ground coat with the powdered glaze rolled onto a heated surface was largely used on hollow-ware. The glaze was usually made of broken glass and borax melted to a glass, dry powdered and saturated with a solution of sal soda and again dried for use.

In 1892 sheet steel stamped ware was added to the Vollrath Company's line. Before this date steel was of such composition that, if pickled as today and coated with a present day ground coat, poor ware would be produced. With extraordinary care in annealing, pickling and the ground coat treatment, very fine sinks were made. This merely illustrates that successful enameling is by no means merely ground and finish enamel formulas, but rather a combination of all things entering into every detail of manufacture from source to completion. I cite this to show that the steel then produced in the United States was not fit for enameling. It was said at this time that the mottled-gray ware on metal direct, was so made with only English iron, and that no other steel ware was made in the United States until mild drawing steel was manufactured here. At this time there was a foreign patent for a mottled-gray enamel, placed directly on the steel, such enamel having a greater alkali content than was necessary for the same enamel on iron. This was no doubt the beginning of the spreading of this industry in this country.

About 1900 various colored wares appeared on the market, such as inside white, outside turquoise blue, outside copper-red. Today, the white-ware and white and mottled-gray wares are the most popular wares.

I believe in this period fewer changes have been made in enameling formulae than have been made in steel to make it more suitable for the enamelers. It has been the common saying among enamelers that one formula, no matter how good for its particular purpose in one plant, will not work in another plant when used for the same purpose. This merely illustrates the radical difference in the different processes and the vital importance of each, and in the final analysis the organization has much to do with successful ware.

Thirty years ago, Germany had three hundred enameling factories while the United States had but a few. Today reasonable protection and the increasing appreciation of the public of the value of enamel ware has built up the industry. Naturally, mechanical developments, such as gas welding, increased variety of sizes and shapes, improved enamel finish, have all contributed to this growth, and the public has developed more of an interest in sanitation in the kitchen.

It is not my purpose to deal with the late improvements in enamels, mechanical developments, smelter or muffle designs, with which you are familiar. The foregoing, however, briefly put, covers in part some of my experiences as enameler for the Vollrath Company. It is due to constant experiment in our search for something better that our product has reached

its present standard. It has been our policy to give direct and personal attention to the education of the younger generation in our organization in the intricate art of enameling, and impressing on all concerned the vital importance of each step in the process. By this process they will be given a start in enameling with my fifty years of experiment and experience in the background.

THE VOLLRATH CO.
SHEBOYGAN, WIS.

DEVELOPMENTS IN ENAMELING TECHNOLOGY DURING THE PAST TWENTY-FIVE YEARS

BY H. F. STALEY

The Founding of the Enamel Industry

It is evident that the foundations of modern enameling technology in this country were laid broadly and strongly in the quarter of the century between 1875–1900 and it would appear consequently that there was little to be done in the recent quarter of a century. It is true that the achievements of this latter period have not been as spectacular nor as fundamentally important as those of the preceding one. The opportunity to establish a technology occurs only once. Therefore, those of us who are engaged in the enamel business now and those who follow us will never have a chance to do such epoch-marking work as that done by the men of broad vision in the enameling industry during the last quarter of the 19th century. However, while it has not been possible to lay the foundations during the last twenty-five years, it has been possible for those engaged in the enameling industry during this time to rear a fine and noble superstructure on the foundations built by the previous generation.

The Achievements of the Past Twenty-five Years

The history of the technical development in the past twenty-five years has been marked not so much by startling new discoveries as by the development and elaboration of methods and practices established in earlier periods. This has led to the production of more durable and more beautiful enamels at less cost, to the speeding up of production, especially by the use of mechanical improvements, and in general to a lessening of the cost of enameled wares and a widening of their usefulness, which in turn has made possible the growth of the vast enameling industry of the present time.

For obvious reasons it is not possible for anyone to list with certainty, and with assurance of the approval of his readers, the outstanding tech-

nical developments in the enameling industry of the past twenty-five years. This is true not only because the importance of the various items will vary according to the personal viewpoint of the observer, but also because at this time it is not possible to forecast the future and to know the effect certain developments of this period will have on the future course of the industry.

Simply at my personal appraisal, I am inclined to list the following as the most marked achievements in enameling technology during the last quarter of a century:

1. The invention of the automatic dredge for dry coat enameling.
2. The introduction of machine molding of bath tubs.
3. The development of the use of antimony compounds in dry coat enamels.
4. The development of decorative enameling of cast iron by the wet process.
5. The formation of the Enamel Division of the AMERICAN CERAMIC SOCIETY.
6. The coöperative investigation of fish-scaling in enamels on sheet steel conducted by the Enamel Division of the AMERICAN CERAMIC SOCIETY and the United States Bureau of Standards.

The Automatic Dredge

The first two achievements were performed about the year 1900. They were therefore just on the border line at the beginning of the past quarter of a century and the end of the previous one. The marked effect of the invention of the automatically actuated dredge by Mr. James W. Arrot, Jr., has been described by Mr. Dawes. The introduction of this dredge with the other mechanical improvements that were naturally a corollary of its use, such as the employment of power driven enameling tables and mechanically operated furnace doors, cut the force necessary to operate a furnace in half and at the same time made the work of the remaining half of the force much easier and more endurable. Moreover, the few men now employed on a furnace can make twice as many pieces of ware as the large force formerly did. It is hardly conceivable that the cast iron enameling industry would have reached its present growth if it had not been for the introduction of the automatic dredge.

Machine Molding of Bath Tubs

The invention of machine molding of bath tubs by Mr. John C. Reed has also been emphasized by Mr. Dawes. Following Mr. Reed, others contributed to the development of machine molding and several methods are now in use. However, it appears that full credit for the original achievement belongs to Mr. Reed. The introduction of machine molding of tubs reduced the labor cost enormously, reduced the amount of equipment and floor space required for manufacture very much and at the same

time made possible the production of uniformly better castings. This achievement was fundamental to the vast expansion that has taken place in the sanitary enameling industry.

Use of Antimony Compounds in Enamels

The development of the use of antimony compounds in dry coat enamels in this country took place between 1905 and 1910. The compound in general use is sodium antimonate or mixtures of sodium antimonate with other chemicals; oxide of antimony has also been used to some extent. The value of the introduction of antimony compounds as opacifiers in enamels is still a question of debate among those engaged in the industry. Whatever we may think of the advantage of using these materials, the fact remains that the introduction of antimony compounds into enamel mixtures made necessary radical changes in enamel compositions and changes in the technique of melting enamels. Those engaged in the enameling industry met the issue successfully and large amounts of enameled sanitary ware of good quality are now being made in this country with the use of antimony compounds. To develop a technique for using successfully materials of seemingly such erratic behavior was a severe test of technical ability. The experimental work connected with the development of antimony bearing enamels was conducted at the same time in various factories. Therefore, it is not possible to give specific credit for this achievement.

Decorative Enameling of Cast Iron

A new technique of enameling stove parts and other articles of cast iron in a variety of colors by the wet coat process has grown up in this country during the last ten years. For the past seventy-five years, a certain amount of cast iron hollow-ware has been enameled in this country by the wet process. However, the enamels used were not comparable in elasticity and beauty of finish to those now being used for decorative enameling of cast iron. It appears that the introduction of this type of enamel is leading to what seemed impossible—a practically new enameling technology and a new enameling industry. It is the prediction of experienced stove manufacturers that within ten years the old black stove will have disappeared from commerce and that every stove made will be enameled. A great many other articles manufactured from cast iron are now being enameled by the wet process and it is probable that the use of such enamels will be greatly extended. The writer is not sure to whom the credit for the introduction of this type of enamel belongs. It seems certain, however, that Mr. Karl Türk was a prominent figure in the early stages of the development of this branch of enameling technology.

Formation of the Enamel Division

The establishment of the Enamel Division of the AMERICAN CERAMIC SOCIETY and the work by the SOCIETY that led up to the establishment of that Division was one of the notable developments in enameling technology during the past twenty-five years. The relation of the AMERICAN CERAMIC SOCIETY to the enameling industry dates back to the year 1906 when the first paper relating to enameling was contributed to the *Transactions of the Society*. The first few tentative efforts in the way of papers did not hit directly at the problems confronting the enamelers of the country and did not arouse much interest on the part of the enameling industry.

Beginning with the annual meeting in 1911 and the publication of Vol. 13 of the *Transactions* in the same year, a change was noticeable in the character of most of the papers published. The difference lay in the obvious effort to be of direct help to the enamelers by discussing the real problems of the enameling industry in language practical enamelers could understand. At first the industry was somewhat skeptical, but finally some came to understand the spirit in which we were working and realized that at least part of the papers read were worthy of study. Therefore, between 1911 and 1919 there was a gradual increase in the number of members of the SOCIETY from the enameling industry.

The Enamel Division was organized at the annual meeting of the SOCIETY in February, 1919, with an initial membership of sixty-two. From the very first meeting of the Division, when it was found that it was possible for the men engaged in the enameling industry to meet and discuss the many problems confronting them in their work, there has been a very decided spirit of coöperation and mutual helpfulness in the Enamel Division. The increase in the membership of this Division in the past few years has been phenomenal. At present there are over two hundred and fifty members, which is a far larger number than any one previous to that time surmised were at all interested in the technical aspects of enameling. The support given in the way of corporation memberships by enameling firms has been very helpful and inspiring to the Division. The impulse to technical development given by this large group of enamel technologists working together is shown by the marked increase in number and improvement in quality of papers dealing with enameling subjects, by the marked increase in individual and coöperative experimental work done in the various plants, and by the increased efficiency in the work of the individual members.

Mr. R. D. Landrum was organizing chairman of the Division and its first councillor. The annual chairmen have been Mr. John Sanders, Mr. E. P. Poste (two years) and Mr. B. T. Sweely. Mr. R. R. Danielson has been secretary of the Division since its formation. Every member

of the Division has contributed to its success, but to these gentlemen must go the credit of leadership in the formation and conduct of the affairs of the Division.

Investigation of Fish-Scaling

The establishment of an Enamel Section in the Bureau of Standards has been of material benefit to the enameling industry and particularly to the work of the Enamel Division of the SOCIETY. It has furnished a well-equipped laboratory with a staff of high-grade research men to do the laboratory work necessary in connection with the coöperative investigations being carried on by the Enamel Division. The most noteworthy of the researches conducted up to the present was the coöperative investigation of fish-scaling in enamels on steel conducted by the Enamel Division and the Bureau. In breadth of scope, accuracy of execution, number of individuals and firms coöperating, and potential value of results, this is without doubt the finest piece of research work ever conducted in the field of enamel technology. Many firms, laboratories and individuals coöperated in this investigation but the credit for carrying it to such a successful conclusion must go to R. R. Danielson, W. H. Souder and their co-laborers in the Bureau of Standards.

Conclusion

There are many phases of the development of the enameling industry which it has not been possible to discuss. There are many men who have been active in promoting the development of enameling technology who have not been mentioned. We all know these men and in our thoughts of them give full credit. If there are any inaccuracies in my statements they are absolutely open to correction for I will be only too glad to rectify any errors.

It was St. Paul, I believe, who said, "I am a citizen of no mean city." In the same spirit we who are engaged in the enameling industry may say we are members of no mean profession. The enameling industry of this country is a big business, a useful business and one which requires ability, alertness and energy. It is a business in which any of us may be proud to say we have a part.

METAL & THERMIT CORPORATION
120 BROADWAY, NEW YORK, N. Y.

TWENTY-FIVE YEARS PROGRESS IN THE GLASS INDUSTRY

BY E. W. TILLOTSON[1]

The Arts of Life supply instances of periods when the Genius of Invention has been scarcely manifested; and others, when its progress has had accelerated velocity; among which latter the present seems most interesting.—*Simeon Shaw*, 1837.

[1] Assistant Director of the Mellon Institute of Industrial Research of the University of Pittsburgh, Pittsburgh, Pa.

In a recent paper[1] a vivid story of the glass industry of the latter part of the last century was presented by one who has been in intimate contact with all phases of the industry. That story was interrupted at a period about twenty-five years ago and so this account is, in a sense, a continuation of it, although the author has not the advantage of long personal contact. Twenty-five years ago the use of natural gas had become well established as a fuel in the glass factory. However, the design of furnaces for the application of this fuel had not been worked out and in general the "deep eye" pot furnace was in common use. The tank furnace had been introduced by Mr. James A. Chambers about ten years before and this type of furnace was coming into favor in the window glass factories. The machines for the handling of materials and for the fabrication of glassware with which we are now familiar were for the most part undreamed of in the glass factory. At most, they were, twenty-five years ago, in the early stages of development and were looked upon with suspicion by the majority of glass workers. In the application of chemistry to the glassmaking processes the greater part of the advancement both in this country and abroad has taken place during the period under consideration. The making of "lime flint" glass of good color had been accomplished over 50 years ago by using sodium bicarbonate in the place of the LeBlanc soda ash which produced an off-color glass, but with the advent of the Solvay process soda ash the use of the expensive bicarbonate became unnecessary and by 1900 "lime flint" of good quality was being melted in tanks.

Growth of the Industry

During this period the glass industry as a whole has enjoyed a normal expansion, particularly since natural gas became available. This growth may be shown conveniently by the quantities of sand consumed in the industry, since sand constitutes fairly constantly 70 to 75% of the substance of the glass.

Year	Short tons	Value
1902	943,135	807,797
1905	1,060,334	1,107,730
1910	1,461,089	1,516,711
1915	1,884,044	1,606,640
1916	2,018,317	1,957,797
1917	1,942,675	2,685,014
1918	2,172,887	4,209,728
1919	1,827,409	3,593,371
1920	2,165,926	4,748,690
1921	1,280,359	2,314,314

Natural gas, because of its convenience and availability did much to stabilize the glass industry by putting it on a profitable basis, and the

[1] H. L. Dixon, *Jour. Amer. Ceram. Soc.*, **4**, 85 (1921).

glass manufacturer was thereby enabled to direct his attention to the development of mechanical appliances. This is illustrated best, perhaps, by the plate glass industry, which, until the advent of natural gas, had not been established permanently in spite of several attempts. Today we are witnessing the retirement of natural gas and the introduction of producer gas as the standard fuel of the glass industry. This development brings with it new problems in the design and construction of glass furnaces and leers, the solutions of which will be less difficult, perhaps, because of the experience gained with natural gas.

Development of Mechanical Appliances

Practically all the automatic and semi-automatic glass-forming machinery has been developed to its present successful commercial use in the past 25 years. The following table[1] presents some of the noteworthy advances in the glass industry.

To discuss the development of each of the great mechanical inventions and its effect on the industry would require more space than is available here; but it may be appropriate to point out that the automatic machines have increased the production per man, it is estimated, from five to ten times, and, in addition, a better quality of ware and a more uniform product are secured. Then, too, the general use of machinery has made for larger installations and more permanent buildings, and this result has necessitated the introduction of mechanical appliances for the handling of raw materials, for weighing and mixing the batch and conveying it to the furnaces, and also for conveying the glass articles from the presses to the leers. The continuous mechanically operated leer for small articles is of comparatively recent adoption.

Advances in Chemical Technology

As mentioned before, the introduction of Solvay process soda ash was a boon to the glassmaker since it did not contain the color-forming impurities which were present in the LeBlanc soda, and made possible the production of a fair quality of "crystal" glass or "lime flint" in the tank furnaces. Of late years, the use of selenium in the place of manganese dioxide as a "decolorizer" has improved materially the "color of glass produced in tanks and has insured a more uniform color from day to day."

Among the new types of glassware developed recently should be mentioned the translucent alabaster glasses which have found a wide use for illumination purposes. While this type of glass is relatively old the present day examples represent distinct advances.[2]

Among the outstanding developments in new glasses the most important

[1] Tillotson, *Chem. & Met. Eng.*, **23**, 461 (1920).

[2] See A. Silverman, "Alabaster Glass," *Jour. Amer. Ceram. Soc.*, **1**, 247 (1918).

SOME NOTABLE DEVELOPMENTS IN THE GLASS INDUSTRY

Innovation	Date	By whom introduced	Place	Comments
First glass factory in America	1608	.....	Jamestown, Va.	For the manufacture of beads and bottles.
Pressed glass	1827	A carpenter, name unknown	Sandwich, Mass.	The Boston & Sandwich Glass Co., Deming Jarves, mgr.
First plate-glass factory in America	1857	.....	Williamsburg, N. Y.	Failed by reason of competition from France and Belgium.
Lime-flint glass	1864	William Leighton, Sr.	Wheeling, W. Va.	This invention nearly extinguished the old flint industry.
First regenerative pot furnace	1865	James B. Lyon	Pittsburgh, Pa.	Built at the O'Hara Glass Works, for use with producer gas.
First continuous tank in America	1879	Poughkeepsie Glass Works	Poughkeepsie, N. Y.	For the manufacture of bottles.
First use of natural gas in melting glass	1883	Bradford Window Glass Co.	Bradford, Pa.	In 1884, gas was used for melting flint glass in the Riverside Glass Works, Wellsburg, W. Va.
Prepressed blank	1882	Philip Arbogast	Pittsburgh, Pa.	An important step in the development of the automatic bottle machines.
Continuous leer for window glass	1882	Cleon Tondeur	Dunhamville, N. Y.	Fox & Sons Window Glass Co. (the "rod" leer).
Continuous tank for window glass	1884	United Glass Works	Streator, Ill.	.....
Wire glass	1892	Frank Schuman	Tacony, Pa.	.....
Favrile glass	1892	The Tiffany Furnaces	Corona, L. I.	.....
Selenium ruby glass	1894	Nicholas Kopp	Pittsburgh, Pa.	.....
Flint "lime" glass melted in tank	1898	Charles H. Runyon	Rochester, Pa.	Keystone Glass Co.
Continuous leer for plate glass	1898	Marsh Plate Glass Works	Walton, Pa.	.....
Fire polishing cut glass blanks	1899	Michael J. Owens	Toledo, Ohio	.....
Automatic bottle machine	1899	Michael J. Owens	Toledo, Ohio	.....
Machine drawn window glass	1900	John J. Lubbers	Pittsburgh, Pa.	The American Window Glass Machine.
Machine drawn sheet glass	1903	Irving W. Colburn	Franklin, Pa.	The Libbey Owens Sheet Glass Machine.
Flowing device	1903	Homer Brooke	Jersey City, N. J.	Used in connection with automatic machines.
Continuous leer for flint glass	1908	Maryland Glass Corporation	Baltimore, Md.	The intermittent pan leer had been in use for fifty years.
Low expansion glasses	1915	E. C. Sullivan & W. C. Taylor	Corning, N. Y.	Pyrex glass.
Hartford-Fairmont feeder	1915	Karl J. Peiler	Fairmont, W. Va.	For use with automatic machines
Automatic tube machine	1916	Edward Danner	Toledo, Ohio	.....
Automatic bulb machine	1917	August Kadow	Toledo, Ohio	The Westlake machine producing bulbs for incandescent lights.

is perhaps the introduction for a variety of purposes of the remarkable low-expansion glasses. The resistance of some of these glasses to chemical attack, in combination with their high resistance to sudden changes of temperature, renders them particularly suitable for laboratory apparatus and also for the more familiar use in the home for baking dishes. One of these glasses at least has proved to be successful as a teapot and an all-glass coffee percolator is to be made commercially available soon. These specific examples are suggestive, at least, of the possibilities in the development of new glasses and in the extension of the uses of glass. Other important advances in glasses for specific purposes are recorded in the patent literature.[1]

This *Journal* contains fairly complete reports of one of the most remarkable developments in the glass industry; namely, the establishment of the manufacture of optical glass in this country. The work carried out in that period teems with much of fundamental value to the whole glass industry. For example, the principles underlying the annealing of glass which were developed mathematically and demonstrated practically are important, not only for the better understanding of glass, but also for designing correctly the leers in which the annealing is accomplished. Of direct interest to every glass manufacturer, also, is the study of "stones," "devitrification" and other defects in glass, the methods of recognizing their cause, and the means of their prevention. In addition, the investigations in connection with optical glass have led to a number of research inquiries which may appear on the surface to be of only scientific interest, but which, after interpretation in the terms of practice, will be found to be of direct practical value.

The recent past, in the glass industry, has been one of glorious accomplishment, the present is a period of undiminished progress, and the future is promising of still greater attainments.

GLASS POTS AND TANK BLOCKS

By A. V. Bleininger

Practical experience has shown that for the making of the principal glass house refractories, pots and tank blocks, the combination of the plas-

[1] See, in particular, the following U. S. Patents:

1,127,042	1,151,911	1,411,133
1,127,044	1,295,298	1,411,134
1,225,147	1,304,622	1,169,571
1,226,088	1,292,147	1,394,296
1,233,486	1,292,148	1,239,051
1,431,166	1,305,793	1,365,797
1,192,474	1,305,794	1,217,956
1,304,623	1,369,988	1,278,164

December 2, 1922

tic Missouri clays with materials of the Gross Almerode type has given the most satisfactory results. On the other hand, it has been found possible to produce such refractories of excellent quality entirely from domestic materials. But it is evident that the conditions of use have a profound influence upon the results obtained. It is not immaterial whether the glass house accessories are properly pre-fired or not, nor how they may be treated in the furnace.

We know now that the Gross Almerode clay owes its valuable properties to its low drying and firing shrinkage, its high bonding power and its constancy in volume upon long continued heating. On the other hand it is not entirely free from certain defects such as its tendency to spall under conditions of sudden heating and cooling. All of these properties are associated with its high content of finely divided quartz. It has been found possible to reproduce these properties in a large measure by the use of natural siliceous clays from American sources and the introduction of finely ground quartz.

While good results are being obtained with the present type of clay refractories for this purpose it is a question whether this will continue in view of the fact that furnace temperatures are being pushed upward. It is possible that we may have to create new types of compositions.

In the molding processes of pots and blocks no decided changes have been made during the past 25 years but a start has been made in the use of the casting process and it is claimed that blocks can be made successfully by machinery. The primitive methods of mixing the materials and the tramping of the clay are being rapidly replaced by mechanical operation. A beginning has been made in the use of improved drying systems. Again, more attention is being paid to the firing of the blocks in the kilns and of pots in the arches. In one instance the tunnel kiln is being used. In a number of plants improved arches have been built and the necessity of proper burning is being realized. There is, however, still much room for improvement in the use of higher temperatures for the pre-firing.

There is need also of improved methods of handling the pots and blocks and other accessories, especially in getting them to the furnace or tank. Draw pots as used in window glass making are too often subjected to extremely severe use through improper heating and irregular turning. The sooner it is realized that the careful handling and use of the glass house refractories are an important part of plant operation and not an annoying detail the more profitable it will be for the business.

Special pot compositions have been brought into use in connection with general glass making as well as in the production of optical and special glasses. Thus Scholes' feldspathic and the porcelain composition of the Bureau of Standards might be mentioned in which the body consists of kaolin, ball clay, flint and feldspar, mixed with whiteware grog, and fired to

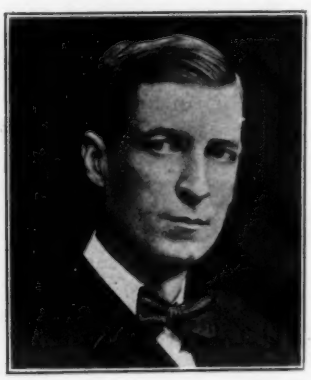
vitrification. Special compositions are used also for the accessories of glass presses provided with automatic feeders.

Summing up we may say that while progress in this branch of the ceramic industry is necessarily slow owing to the long time required to learn the results of any change made, definite advance must be recorded which we may expect to be accelerated as we shall learn more about the facts of glass attack and the changes caused by high temperatures in the structure of these refractories.

IMPORTANT DEVELOPMENTS IN THE GLASS INDUSTRY

By A. W. Kimes

To properly tell of the advancement and improvements in the art of glass manufacture, that have been made within the past 25 years would require an issue of the *Journal of the American Ceramic Society* larger in size than this special edition. To give due credit to the gentlemen who so earnestly labored in an effort to modernize the production of glass and glassware would require greater space than is available. During the period mentioned the process of manufacturing all kinds of glass and glassware, with but one or two exceptions, has been advanced from the hand to the automatic method. Unlimited credit is due scores of men who have taken a prominent part in giving to the glass industry some of the most wonderful automatic machinery used in the production of hundreds of different kinds of glass articles and placing the development attained in the glass business equal to that achieved in any other industry.



J. R. Johnston, most prominent man engaged in manufacture and distribution of hand-made window glass.

Within the past two and one-half decades the Owens bottle machine has been perfected from what was then claimed to be an impossibility to one of the greatest mechanical marvels of the age. Early in its development but little encouragement was given to its promoters. They often were confronted with the statement, "it might make certain ware, but on other lines it was destined to fail." However, today sees this wonderful machine producing in range from the tiniest bottle at the rate of almost 200 a minute to the five-gallon water bottle, entirely automatically made, at the rate of six per minute. Articles produced within these extreme limits include such as the quart fruit jar that is turned out on this same device at a speed of one each second of time.

There are scores of other machines that are automatic in their functioning and many that are semi-automatic in their operation that are commercially engaged in producing glass articles and containers in almost every imaginable size and shape. Regardless of the fact that so much progress has been made within the above specified time, there are still great possibilities for further development.

J. B. FORD, father of the plate glass industry in the United States.

Another automatic marvel to be found in the glass industry is the tube drawing machine generally known as the "Danner." It has been termed by some as a device that works closer to the nature of molten glass than any other machine. This problem is so difficult of solution that but few will express an authoritative opinion. It accomplishes its work in drawing glass tubing of various sizes and uniformity of wall at a rate of about 150 feet per minute, varying according to the diameter, with such apparent ease that the observer is astounded at its efficiency.

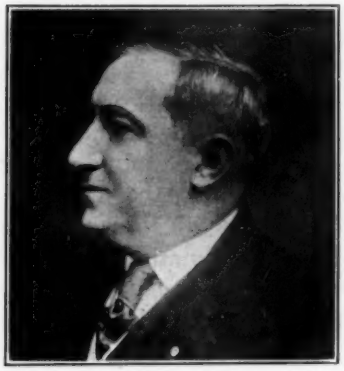
Perhaps one of the most important advancements taking place in the glass industry is that of the introduction and perfection of glass-feeding and flowing devices, which by their various methods transfer the molten glass from tanks to different types of glassworking machinery. Many of these inventions are highly successful and have accomplished objectives almost beyond anticipation.

CHARLES W. BROWN, president of the Pittsburgh Plate Glass Co.

There are a number of other machines busily engaged in the production of scientific and other kinds of glassware that are no less wonderful but equally meritorious in achievement in their respective lines, that cannot be described here by reason of the necessity of their operators' desire to keep their points of superiority concealed lest they be used in an unjustifiable manner.

Passing to the flat glass industry the advancement in this line has been no less remarkable. In this branch of the trade there is to be found the American window glass cylinder-drawing machine which has attained such a high state of efficiency that 12 machines attached to one tank are capable of drawing cylinders 518 inches in length after the shoulder and lower ragged edge have been removed and

of any desired diameter up to 33 inches. The glass drawn varies in thickness from 32 sheets to the inch up to almost quarter-inch crystal glass. In this connection it is fitting to say that within the last month mammoth tanks which measure more than 140 feet in length have proven themselves to be startlingly efficient in operation, two attaining a production per machine during an entire week's operation that is most remarkable. The production of one of these tanks equalled 91.4 fifty-foot boxes in each eight-hour turn, and maintained that speed one entire week. A duplicate tank in another factory exceeded this record by drawing 92.1 fifty-foot boxes of glass per turn. The quality of this large production is equal to that produced anywhere.



D. K. ALBRIGHT, manager of the Allegheny Plate Glass Company, Glassmere, Pa.

Another creation that has proven to be a commercial success, within the period under discussion, is that known as the Libbey-Owens sheet glass method. By this process the glass is melted in a tank and by skilfully devised methods continuous sheets of glass are drawn in various thicknesses and ranging up to more than 80 inches in width. This is another mechanical wonder to be found within the scope of the glass industry.

Numerous experiments have been made to perfect different machines that will draw flat sheets perpendicularly from the tank, or from a compartment attached thereto. These machines have been developed to a point where their inventors claim them to be commercially successful.

W. L. CLAUSE, chairman of Board of Directors, Pittsburgh Plate Glass Company.

A common expression heard when discussing the method of manufacturing plate glass is that there had not been any improvements made since its first introduction in America; but within the last decade this statement is entirely erroneous, as material progress has been made resulting in revolutionizing the early practice. The modern plate glass works of today are entirely unlike those in operation at the beginning of the present century.

Perhaps one of the greatest innovations successfully achieved was that

of supplanting the pot furnace by the tank method of melting plate glass. Like unto many other new ideas, many predicted its ultimate failure. Rapid strides have been made in the handling of raw materials, factory operation and conveyance of the larger sheets of plate glass found in the largest display windows.

Developments in the composition of other kinds of glass and glassware have been far beyond general expectation. We might mention among some of the greatest achievements the introduction of "Pyrex" glassware made by the Corning Glass Works, of Corning, N. Y., the "Oven Ware" of the H. C. Fry Glass Company, Rochester, Pa., and heat-resisting glass produced by other glass manufacturing companies. A new creation is that of safety, or bullet-proof glass, which generally consists of two thin sheets of glass between which is placed a composite material then subjected to predetermined heat and pressure which unites them into a solid mass and produces a glass that will withstand a severe shock or completely retard the passage of a bullet; the glass may be shattered but still retains its shape and form.

W. L. MONRO, president and general manager of the American Window Glass Co., Pittsburgh, Pa.

The foregoing outline mentions but few of the important developments that are to be found in the glass industry and it can be safely predicted that within the next quarter of a century greater strides will be realized.

PRODUCER PROGRESS DURING THE PAST QUARTER CENTURY

BY W. B. CHAPMAN

Twenty-five years ago one lone mechanical producer at the Pencoid Iron Works, designed by the then Chief Engineer of the Company, Mr. W. B. Hughes, was in daily operation proclaiming to all who came to see it that a mechanical producer could be built that would actually run and perform a large part of the heavy manual labor required for making producer gas. This original producer is still in operation.

For over a decade no further advance was made and no one could be induced to follow the lead of the Pencoid people. Then, two years before the Hughes patents expired, the Harrisburg Pipe Bending Company listened to Mr. Hughes importuning and ventured an installation, the success of which led the Pennsylvania Steel Company to adopt the new

mechanical producer for the exacting duty imposed by their large open hearth furnaces. The installation was a success from the start, and from that time on the progress of the mechanical producer was rapid. We now seldom hear of any one installing old-fashioned hand-operated gas producers, and the old gas house adage that "there is usually more gas in the poker than in the coal" is rarely heard.

Probably 1,000 tons of coal and 1,000 days of labor are now saved every day in the United States because of the contribution of pioneer work done on the mechanical gas producer by W. B. Hughes. This is also true to a considerable extent of the other two large producer manufacturers that followed Mr. Hughes' lead, *i. e.*, the Morgan Construction Company, the Chapman Engineering Co., and later R. D. Wood and Company added its contribution to the producer gas art. We now have four different types of mechanical producer on the market, each doing good work and each having a distinct individuality of its own.

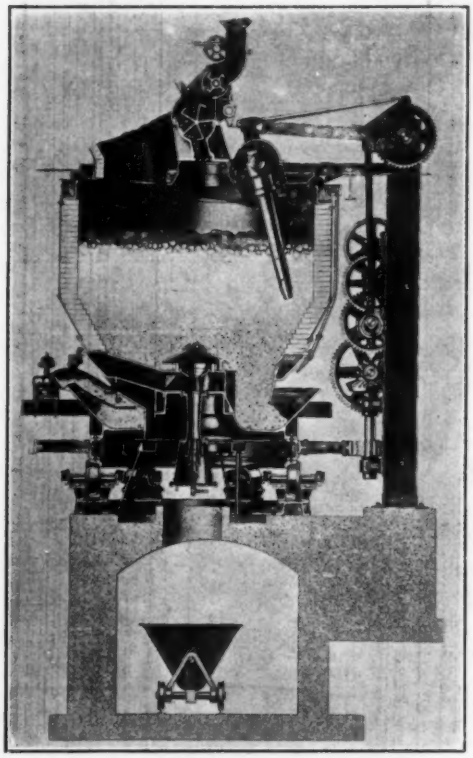


FIG. 1.—Hughes gas producer.

Before the advent of the mechanical producer, two automatic coal feeds, the Bildt and the George, were developed and extensively exploited. But they did not make much of a contribution toward solving the problems for which they were designed and ultimately were abandoned.

Meanwhile as the Hughes producer was gaining in favor, several unsuccessful efforts were made to place on the American market producers of European design having a revolving ash pan with a large non-circular or irregular shaped blast-box which projected well up into the producer and slowly revolved with the ash pan, thus crushing and forcing out the ashes. The writer spent many months in trying to handle various American coals with this type of European producer. It did excellent work in so far as it went. It crushed the ashes and removed them in a way that left little to be

desired but the agitation did not reach far enough up into the fire where the clinkers were being made. Moreover, there was no agitation at all in the middle and upper portion of the fire-bed. The European type may work satisfactorily with certain free-burning European coals (though we doubt it) but it will never answer for American coals that make trouble not only in the bottom of the fire-bed but in the middle and top as well.

So attention in America was concentrated on the stirring or agitating of the middle and upper part of the fire-bed, and for the time being the under portion was neglected. The Chapman Engineering Company tried agitating the surface and at the same time twisting the upper half of the fire-bed over the lower half upon which it rested. This was done to twist out the blow holes and produce agitation without requiring an agitating member. But in the larger sizes there was too much agitation near the walls; so the twisting method of solving the problem had to be abandoned.

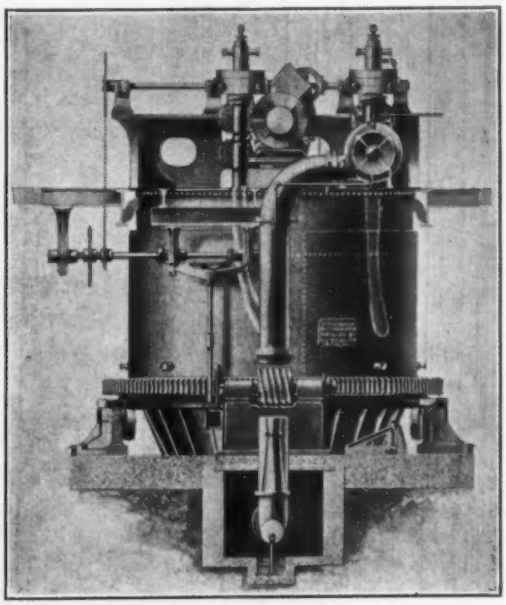


FIG. 2.—R. D. Wood gas producer.

The Morgan people next brought out a successful producer in which surface agitation alone was featured, it being claimed that anything deeper than surface agitation was detrimental to good gas making. This Morgan Producer, equipped as it is with automatic feed, swinging U-tube and mechanical ash removal, is one of the most popular in the steel trade. It was the first successful producer to appear after the Hughes.

About the same time appeared the Wood Producer (1915) with its two vertical stirring fingers. The two stirrers give a larger capacity but make it impossible to operate the producer at less than half load. In this producer the ashes are removed mechanically every few hours instead of only once or twice a day as is the case with the Hughes and Morgan. Some remarkable results have been obtained with the Wood Producer, and its twin the Camden. This type is quite popular in the glass trade.

In 1916, the first Chapman Agitator was built. It was tried first in a zinc plant using anthracite coal because it was thought that it might not

work on bituminous coal. It did not do enough good on fine anthracite coal to be worth while, so it was rebuilt and moved to a window glass factory in Indiana for another trial. Here it laid around on the ground for many weeks before being given a trial, as it was said that the agitator would never rise and fall automatically with the varying height of the fire-bed. When finally it was tested it worked right from the start and no fundamental changes have had to be made in the six years that have elapsed since then.

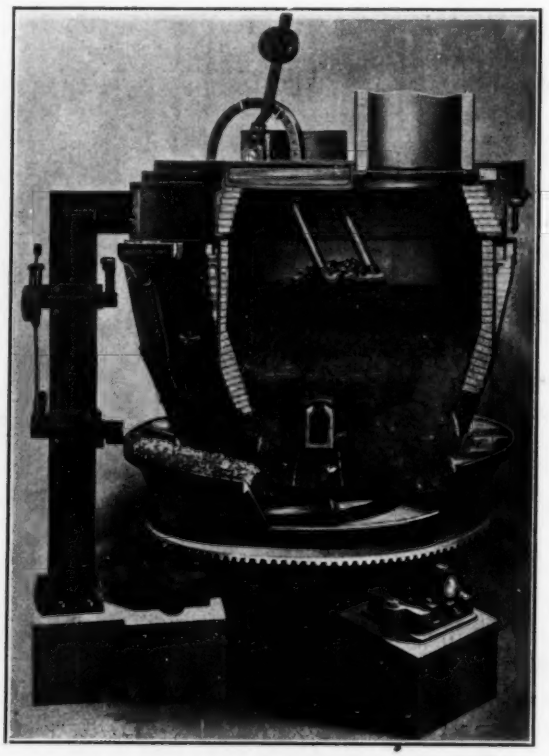


FIG. 3.—The Morgan producer gas machine and Dyblie reversing valves.

In making producer gas there are three steps:

1. Feeding and spreading the fuel
2. Agitating the fire-bed
3. Removing the ashes

In all of the four types of mechanical producers on the market all three of these steps are performed mechanically, although in no two of them is this accomplished in quite the same way. All but the Chapman have a revolving wall carrying a revolving fire-bed. A revolving bed is required

by the eccentric location of the automatic feed and is also required by the eccentric location of the agitating members used. In the Chapman the agitator is centrally located and the fuel is fed centrally; hence it is not necessary to revolve the heavier producer walls and fire-bed.

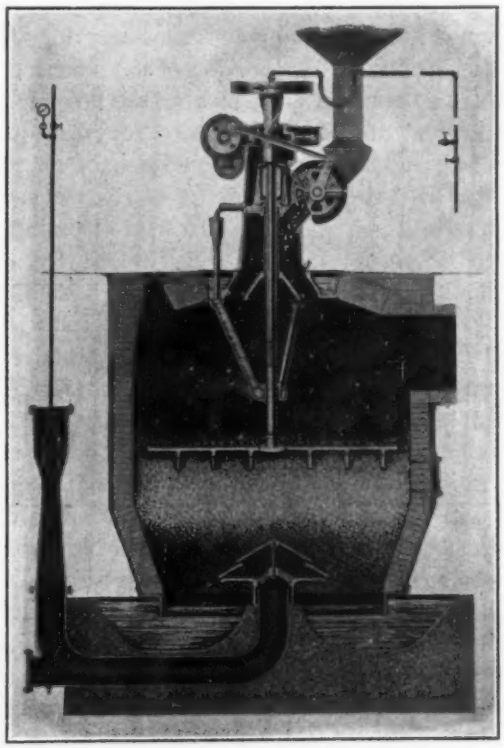


FIG. 4.—Chapman floating agitator producer.

In the Hughes and Morgan method producers the method of ash removal employed makes it necessary to revolve the ash pan. In the Wood and Chapman designs, the ash pan is stationary and hence made of concrete. In the Hughes and Morgan producers the top is of metal and water-cooled, while in the Wood and Chapman type the top is of fire brick.

The Morgan swinging U-tube and the Chapman Agitator operate automatically in the surface of the fire-bed, in contra-distinction to the vertical stirring fingers of the Hughes and Wood types, which have to reach to within a few inches of the bottom of the fire-bed for best results. Those producers in which the height of the agitating member automatically changes in height are especially flexible as to capacity. They will give about as good results at $^1/_{10}$ capacity as at maximum.

The Chapman Agitator has been tried many times without the agitating fingers and in spite of the fact that the cross arm passes through the surface of the fire-bed three times as frequently as in other types, it has been found in every case that the stirring fingers add 25% to 33% to the effectiveness of the agitator. There are some 350 of these agitators in service in the glass industry.

But most of these differences in producer design are more apparent than real. The results actually obtained do not differ as widely as one might expect. In all four types of mechanical producers it is not difficult to gasify twice as much, and sometimes three times as much fuel as in the old-style hand-operated producers; and at the same time a much better

gas can be made. It is easier to make a 150 B.t.u. gas in a mechanical producer than a 120 B.t.u. in a hand-operated one.

An installation of mechanical producers usually saves about 25% of the fuel, but it rarely happens that this saving of 25% is effected in the producer itself. The greater portion of the saving is brought about in the furnace due to the richer gas which makes possible a higher initial flame temperature and due also to the more uniform quality and quantity of the gas which makes it possible to adjust the air very closely to the needs of the furnace. Before the advent of the mechanical producer it was common practice for each furnace to waste from 10 to 30% of the fuel because it was impossible to keep the air adjusted to suit the fluctuations in the quality and quantity of the producer gas.

The new (1921) Chapman Continuous Producer attempts to combine the advantages of the European method of continuous (instead of intermittent) ash removal with the features of the Chapman Agitator. The ash beam that withdraws the ashes from this producer moves continuously at any desired speed from $^1/_2$ revolution in an hour to one revolution a day. It thus makes a continuous (although slight) agitation of the ashes upon which the fire-bed rests. This is a distinct departure in American gas producer practice and its effect is being watched with interest. Personal attention and hand labor are reduced to a minimum.

About 10 years ago a number of leading glass makers—possibly a dozen in all—put in installations for making clean producer gas. It was erroneously supposed that if natural gas could no longer be had the next best thing would be washed producer gas—especially for the leers. However, it was learned from experience that a clean gas plant costs about twice as much to build and operate as a raw gas plant. As a result most of the installations have been abandoned. It is now possible to buy a good muffle leer that does not require clean gas.

The present trend in gas producer practice is toward simplification, labor saving, automatic regulation of gas pressure and of steam and air mixture. There is also a trend toward better methods of flue cleaning.

THE CHAPMAN ENGINEERING COMPANY
NEW YORK CITY

RECUPERATIVE FURNACES FOR THE GLASS INDUSTRY

BY W. B. CHAPMAN

During the past twenty-five years many improvements have been made in the design of glass furnaces. Tanks have been made larger, more efficient, more easily controlled, and less subject to excessive wear; leers have been perfected of the muffle type that permit the use of raw producer gas without risk of discoloration; but perhaps the most distinct advance in furnace design has been the perfection of the recuperator and its application to glass furnaces.

The recuperative furnace, because of its potential possibilities for better control of operation and economy of fuel, has long attracted the interest of glass manufacturers. But until the past decade the difficulties encountered in practical construction and operation have appeared to be insurmountable. Now that a simple and practical solution has been found for these difficulties the recuperative type of furnace is fast gaining

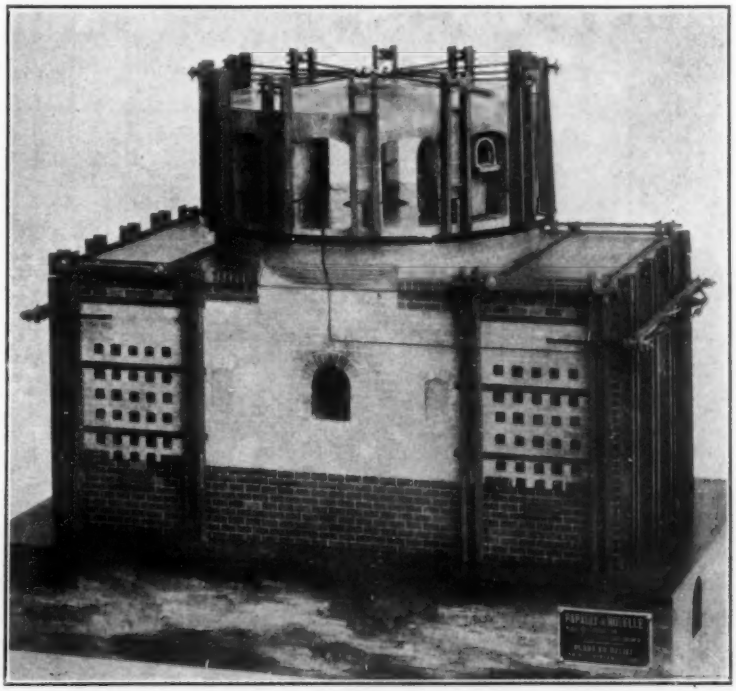


FIG. 1.—Model of Chapman-Stein closed pot recuperative furnace.

in favor. Recuperators of the Stein type are being used with marked success not only in closed pot furnaces but in small tank furnaces, day tanks and various kinds of work tanks.

During the War when coal was $75 a ton in Paris the MM. Houdaille & Truquet of that city installed the first Stein recuperator to be used in the glass industry. It saved half the fuel. This plant today with some half dozen duplicates of the original furnace is the mecca of American glass manufacturers who visit Paris. Many of the same type are now to be seen in various parts of Europe and one has been in operation a year and a half in this country at the Imperial Glass Company in Bellaire, Ohio.

At the Bellaire plant, since their recuperative furnace was installed,

the fuel per day has been reduced about 20% and at the same time the output per day has been increased about 35% as compared with their regenerative (reversing) furnaces of the same size. There is also a considerable saving in pot breakage, for due to the even distribution of heat the pots last fully twice as long as formerly. After a year and a half of operation the furnace is just as efficient as when first installed.

The accompanying illustration is of a wooden model of a similar furnace showing one of the pots in position. There is a single eye in the center of the furnace. The gas and preheated air mix in this eye a few feet below the hearth. The flames pass from the center of the furnace out and down

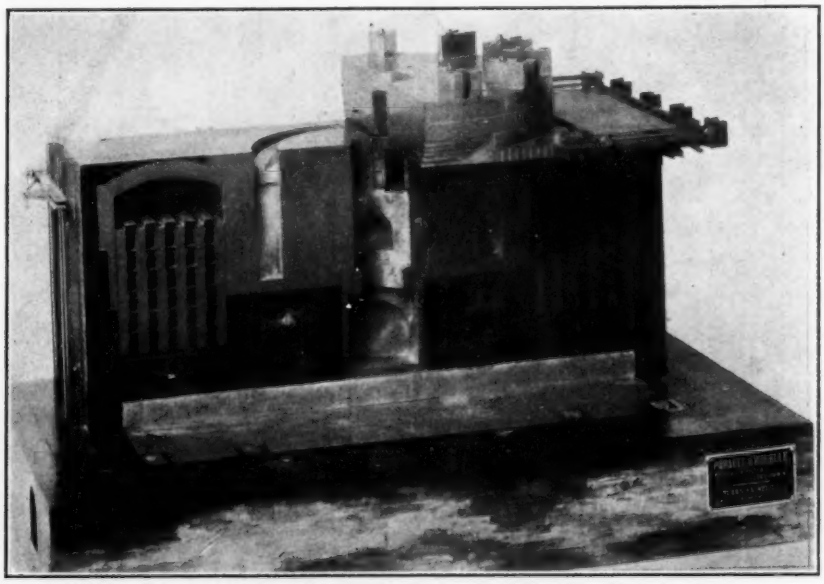


FIG. 2.—Chapman-Stein Furnace

into the off-take ports one of which is located near the base of each of the columns. As there is but one outlet into each column the pots may be set in such a way as to force the hot gases to pass around the fronts of the pots before reaching the outlet, thus bathing the pots in an even temperature of rapidly moving gases—a condition necessary for large output and long life for the pots.

The temperature of the spent gases as they enter the hollow columns and pass downward to the recuperators is about 2500°F, although it is possible to obtain as high as 2600° at this point. The air is preheated to 1900°F, which is probably about 400°F less than the temperature of the spent gases as they enter the recuperator chambers. The spent gases as they go to the stack are about 800°F.

This furnace holds 14 pots each yielding a little over a ton of finished glass. It was formerly of the regenerative type, but was rebuilt a year and a half ago and provided with Chapman-Stein recuperators.

Formerly the capacity was 40 pots a week ending at noon on Saturday. The capacity is now well over 50 pots, and 56 pots can be obtained whenever required. The life of the pots which was formerly under 4 months has been more than doubled. Although the recuperators have been heating the air to 1900°F for the past year and a half and at times to 1950° they show no sign of leakage or depreciation. The fuel consumption has been reduced from 170,000 cu. ft. of natural gas per 24-hour day to 136,000 cu. ft. which makes a fuel saving of about 55% per ton of glass. This furnace ordinarily operates on producer gas but a week's run was made on natural gas so as to get an accurate comparison of fuel consumption with past records.

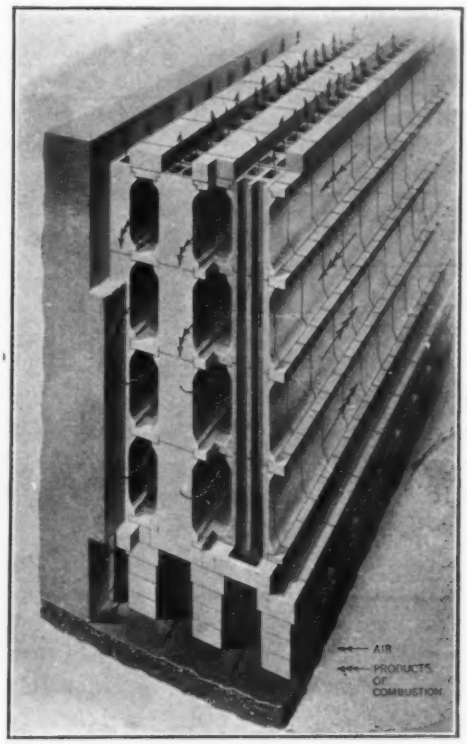


FIG. 3.—Section of Chapman-Stein recuperator.

In connection with the heating of rotary pots used for Owens bottle machines, Stein recuperators have shown a saving of 30% of fuel as compared with the old type of recuperative furnace which usually required a fan for the air and leaked badly. They have also shown the same amount of saving as compared with regenerators used on rotary pots.

On work tanks and other types of glass furnaces these recuperators have shown savings ranging from 20% to 60% per ton of finished product. The cost of a recuperative furnace is always less than the cost of a regenerative furnace.

The distinctive feature of the Stein Recuperative Furnace is that the recuperator air ducts are vertical and have no turn or off-sets. Sufficient natural draft is thus procured through the recuperator to give a slight pressure in the furnace without requiring a blower for the air. By eliminating a fan it is possible to avoid any excessive pressure in the air ducts

of the recuperator. In fact the air ducts at the bottom are under a slight suction (about $^1/_{10}$ inch). This practically balances the suction in the spent gas passages which is about $^1/_8$ inch. There is thus practically no occasion for the air in the air passages to leak through into the spent gas passages. This, in the past, has been the chief cause for failure in the recuperative furnace, for no tile joints could be made tight enough to withstand a positive air pressure from a fan on one side of the tile and the minus pressure of the spent gases on the other.

The Stein recuperator in addition to eliminating the air pressure in the tile reduces the stack draft around the tile by making fewer turns and larger passageways for the spent gases. In this way it is possible to obtain an approximately balanced draft on each side of the tile. The entire recuperator is made with overlapping joints doubly closed so as to permit expansion and contraction without leakage. It is thus made practically leak-proof.

The special recuperator tile are held in place laterally by slabs that direct the flow of the spent gases and also serve to close the joints between the tile. These slabs in turn are held in place by lugs on the recuperator tile.

Each special recuperator tile is reinforced by two vertical partitions which permit the tile walls to be made only $^3/_4$-inch thick thus making possible a very rapid heat transference. By making the vertical passages very small it is possible to heat the air much hotter as there is no room left in the center of the passage for a core of colder slower-moving air, as has been the case heretofore.

The tile are also made so as to break joints in every direction. In setting these tile, no attempt is made to produce a solid mass by using cement, so as to prevent leakage. The large amount of lap of the doubly closed joints, together with the fact that there is practically no difference in the air waste gas pressures on either side of the tile, is adequate insurance against leakage. In many cases these recuperators have had to withstand the jar from heavy trip hammers located nearby and no harm has resulted.

During the past three years 36 of the Chapman-Stein Recuperative Furnaces have been installed in the glass industry.

Chapman Engineering Company
New York City

THE LOG (TWENTY-FIVE YEARS) OF PROGRESS IN THE BRICK AND TILE INDUSTRY

By F. L. Steinhoff

It is fortunate for the author of this article that the story of the developments that have taken place in equipment, methods and conditions incident to the manufacture of brick and tile begins at a date 25 years ago in-

stead of ending there. There would be very little to say for the quarter century antedating 25 years ago. The history of the progress of the industry is reflected to a large degree in the history of the development of the modern plant. A graphic picture of this development can best be gained by a comparison of the advertisements and texts of the modern clay journal compared to that of a trade journal 25 years back.

The subject of this article embraces a number of products and many phases incident to each. Under brick and tile we must consider face, common, paving brick, hollow building tile, drain tile, roofing tile and sewer pipe. Fire brick and terra cotta, two clay products which have made tremendous advances in the last 25 years, will not be included in this dis-

An old type of brick yard of a quarter century ago.

cussion as they are being given separate consideration by able authorities who will chronicle their history. While many processes in the manufacture of these products are common to all, there are a good many specific processes and problems in merchandising that are at great variance.

An industry is naturally influenced in its development by those factors with which it is involved. In the manufacture of brick and tile the chief factors controlling the destiny of the industry are shipping conditions, raw materials, labor, fuel, market, competition within the industry, competition from outside for the markets served by the clay industry, and management. Everyone of these factors—some of course more than others—have had some bearing upon the present status of the industry. It is not too much to say that the combined influence of these factors is almost wholly re-

sponsible for the great development in more refined machinery and equipment.

Each of the factors mentioned above is, in practically every industry, a basic cause for either progress or retrogression and each insofar as it has influenced progress in the clay industry could become the subject of a lengthy and interesting treatise. To dwell upon the progress in each of these factors would therefore require many volumes and a short article such as this is entirely inadequate to provide more than just an outline

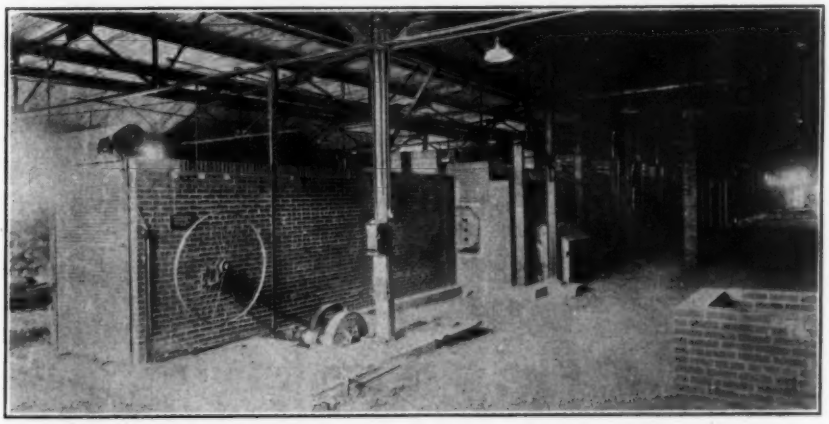
First developments in brick setting machines.

of the history of development. It is obvious that only some of the high spots can be touched and these only very briefly. No attempt is therefore being made in this article to cover each single factor in all of its phases.

Unlike most industries the plane of development in the brick and tile industry has not been uniform. For instance, there is a greater disparity in the clay industry than there is in the steel, textile or rubber business, between the most primitive and inefficient plants now in operation and the

factory that is replete with the latest and most efficient equipment and methods. Why such a condition can exist is at once made evident when it is appreciated that the products are extremely heavy and very low priced per unit of weight. This makes freight rates such a considerable part of the cost that a limitation is put upon wide distribution and the business practically localized. Therefore a manufacturer with crude and inefficient methods can often supply the needs of his community cheaper than a modern manufacturer who must ship some distance. National distribution as in the case of safety razors, clothing, rubber tires, food products, automobiles and the like is unusual rather than the rule in the clay industry.

It is truly astounding what large effect the shipping rates have had upon brick and tile manufacturers, not only in the development of the plants as to their production methods but also as to their markets as well. The



Dressler tunnel kiln at Bradford (Pa.) Brick and Tile Co.

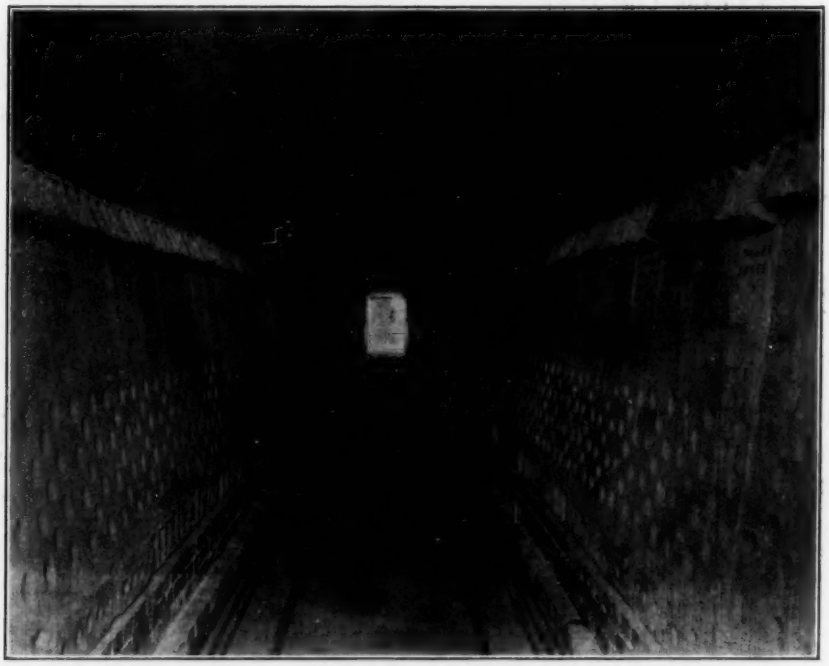
present freight rates are a burden that is sapping the vitality out of a good many plants, giving business to substitute materials and thus materially affecting the market situation in the industry.

Raw materials fortunately are still plentiful and no industry is better fortified with respect to supplies than the brick and tile industry. No estimate of the number of years of supply of shale and clay which is still available has ever been made as there has in the case of iron ore, coal and oil. The various geological ages have furnished this country with a vast and infinite supply of excellent raw materials for brick and tile manufacture—enough perhaps to last to eternity. But this does not mean that the supply of raw material has not affected the development of the industry.

During the period of the last 25 years better clays and shales have been

unearthed. They have enabled the production of higher grade products and those plants better situated have succeeded in weaning business from competing establishments. The tremendous mortality rate in the brick and tile business might perhaps be at least partly attributed to this situation.

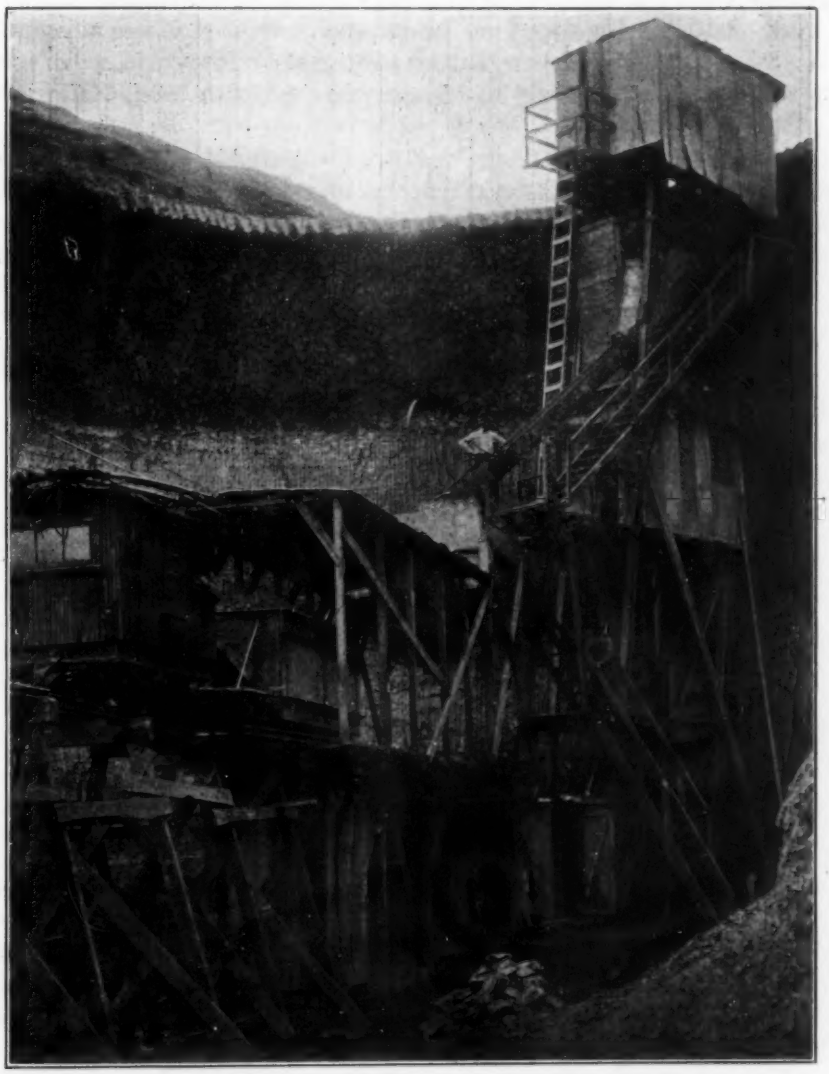
There is, however, at least one section of the country where the supply of available clay has been drawn upon so largely that a lack of raw material is actually threatening the existence of some 15 to 20 plants in that locality. This situation, however, is unusual.



Interior of Dressler tunnel kiln at Bradford (Pa.) Brick and Tile Co.

Labor conditions in the industry have played a vital part in its development. It has perhaps been the greatest factor influencing the development of new machinery and equipment. Cheap labor, which was a keystone of the success of clay plants 25 years ago, has passed. At that time, labor was so plentiful and so cheap that in many instances machinery was actually expensive. The present conditions are altogether different and labor has become very unreliable as well as expensive. The result is that machinery is now cheap and wherever a man is doing the work that a machine can do, there lurks a sore spot which is taxing the vitality of the plant.

It is true that as yet the full significance of the present labor situation is not appreciated by all producers. This is largely because of the great disparity existing in the plane of development of various plants. Shortage of labor has literally forced some plants to become modern industrial in-



A shale planer in operation and an electric locomotive for clay transportation.

stitutions, while others, generally smaller producers, are still struggling with costly methods, employing men instead of machines. The equipment and methods used in the modern plant are considerably different from those

used 25 years back. This is true in each line of manufacture. In discussing the development that has taken place in machinery used for producing clay ware one must keep in mind that there are three processes in vogue. Brick are made according to the dry press, stiff mud and soft mud processes; tile and sewer pipe are made by the stiff mud process.

As is known to most ceramic men these processes involve different quantities of water in the formation of the working mass. It is obvious that the different consistency of the clay in each case effects a difference in the method of manufacture.

It might be mentioned briefly that dry press machines have been constructed on a larger scale, heavier and with greater compressive power than heretofore. Moreover, they are operated on a different principle which involves pressure from both bottom and top plunger simultaneously and

Mechanical stoker for fireboxes on periodical kilns.

with a movement of the molded brick in the molds under pressure. The early dry press machines exerted pressure only by means of the top plunger. As a result of the new developments a stonger brick and better surface are produced.

Auxiliary equipment recently developed permits the production of a rough texture on a dry press brick which in the past was unheard of and enables dry press manufacturers to produce a rough texture face brick, without a change of any kind in their equipment.

In stiff mud brick and tile manufacture the development has been towards heavier machinery with better parts and higher producing capacity. The combined brick machine and marine thrust bearings are some

items that might be mentioned. It has been only during the recent years that wire cut paving brick has been possible. In this connection mention should be made of the various cutters now on the market including one which places a lug on the wire cut brick.

In the manufacture of stiff mud face brick in the last 25 years important changes have taken place in the nature of the product. In addition to the plain smooth face brick there have sprung up a variety of rough textured brick of all shades and colors which offer the purchaser a great range of possiblities undreamed of 25 years ago.

Up to within five years ago the progress in soft mud brick production lagged. Tremendous changes have recently been adopted, however, and soft mud brick now takes a higher rank than many are ready to recognize.

The "moulder" at work, filling the three-pocket moulds. Many of these brickmakers existed 25 years ago but have since given way to "brick factories."

The new automatic soft mud brick machine has cut in half the labor formerly required in operating soft mud brick machines. Sanding, feeding, and dumping of molds are now entirely automatic, making the soft mud brick manufacturer a great deal more independent of his labor.

As with the formation of ware, there has been considerable progress made in every department from the clay pit to the loading platform. Instead of 20 to 30 men with picks and shovels in the pit, you now see but two or three in the up-to-the-minute plant. Horses and two wheel carts have almost passed into memory. In their places, the modern pit equipment consists of some of the following: power drills, steam, gas or electric

shovels; shale planers, traction ditchers; aerial tramways; gasoline, steam or electric locomotives; belt conveyors.

In the clay preparation department the modern heavy duty dry pans were unheard of 25 years ago. Preliminary crushers were practically unknown and vibrating screens had not been considered. Feeders and poidometers were not in use and the modern clay storage was not as now developed.

In power generation and in power transmission there has been noteworthy progress made. Electric motors have been introduced to a considerable extent but the industry has far from completed its installation of more efficient power mechanism. The old steam engine which supplied the entire plant with power is gradually being replaced with the more efficient and satisfactory individual electric power units.

Automatic brick machine for soft mud brick manufacture.

Drying clay ware is a highly important operation. It would be only natural that developments should take place in this department too, and they have been truly great. Contrast what was practically the first method of artificial drying, the hot floor, with the very latest developments, the humidity dryer and you will have a fair picture of the progress in this department. Steam, waste heat and radiated heat dryers are very much at variance in design and operation and the humidity dryer is entirely new.

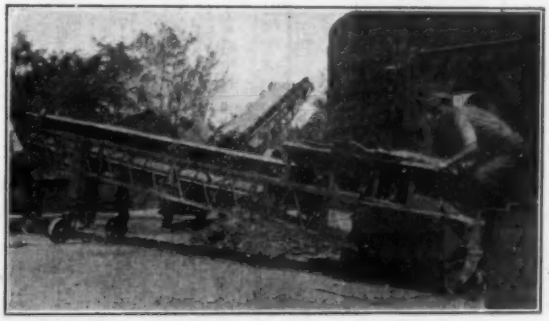
It is in kiln design and operation, however, that the greatest and most tremendous changes have taken place. It is during the last 25 years that the modern tunnel kiln has been perfected and with its use considerable reduction cost of handling of ware has come to pass. All types of con-

tinuous kilns have been improved and the present round down-draft kiln is a great deal more efficient that than of 25 years ago. The safest criterion in gaging the measure of progress in burning clay ware is the evolution of innumerable shades and colors of face brick. The consumer now has his choice of anything from white to black and all intermediate shades.

Portable setting and unloading conveyors, gravity conveyors, storage battery trucks are equipment that have been introduced during the last quarter century. Mechanical coal unloaders, and mechanical trucks for coal distribution at the kilns are comparatively new in the industry.

The recent announcement of an automatic stoker for kiln fireboxes is of especial interest in connection with the progress of machinery in the industry. Brick setting and unloading machines for up-draft kilns were revolutionary changes that have taken place in the manufacture of common brick.

As evidence of the transition of the clay industry from a man-operated to a machine-operated one the figures showing the relative horsepower per

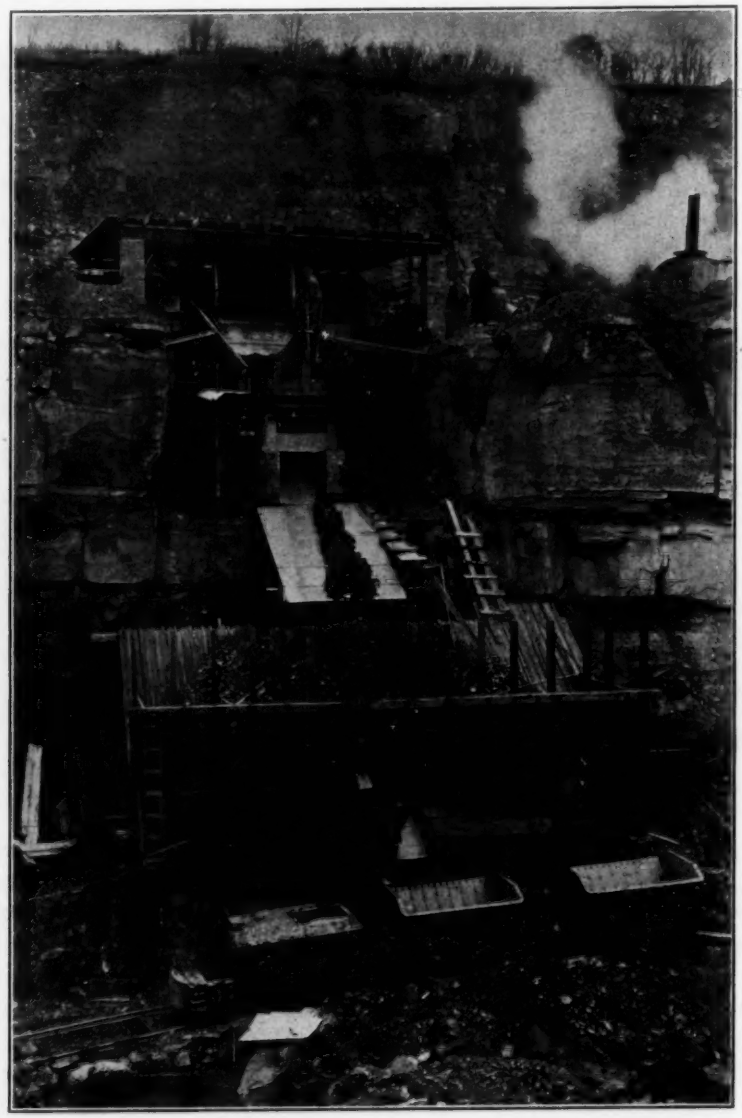


Portable conveyors for unloading brick from kilns to cars or stock sheds.

man in 1914 and 1919 are conclusive proof. In 1914 the horsepower per man was 3.4 and in 1919, 3.7 a gain of 10%. For this advancement manufacturers of clay machinery deserve considerable credit. Their ceaseless efforts to produce better machinery has been no small item in the industry's progress.

The clay products industry is the third largest industrial user of coal. In any industry where coal plays such an important part in the fabrication of the ware, it is but natural that considerable stress would be laid upon the reduction in the use of this commodity in clay ware production. Thus labor and freight rates should not be accredited entirely as being the incentive for the construction of kilns that would save fuel. The continuous burning system, use of fans for expediting burning, the various tunnel and continuous kilns, as well as furnace equipment have had as their main ob-

ject, labor reduction and reduced fuel consumption. Pyrometers and draft gages are also playing an important part in reducing the coal bill of the industry.

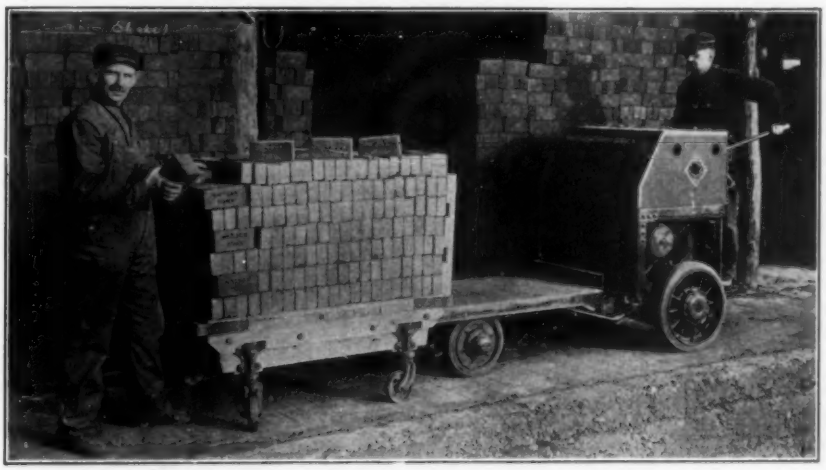


Pit, preliminary crusher, electric locomotive and clay cars at Bradford Brick and Tile Co.

No history of the progress of the clay industry would be complete without mentioning the great forward strides made in the installation and adoption

of efficient cost accounting methods. Manufacturers of brick and tile are realizing more and more that in order to get a fair price for their product they must know what a fair price is, consistent with the cost of production.

In order for an industry to progress its management must have certain ideals and vision. Since management controls the growth and progress of a business, it must follow that management in a clay industry has kept pace with the progress of time. More of the higher grade business men have been attracted into the industry and they, together with engineers who are now found in greater numbers on clay plants, have brought in the ideas and methods of other successful industries—ideas and methods which have assisted toward bringing the industry to its present state of development.



Storage battery lift truck for emptying kilns.

Industrial research was practically nil 25 years ago. The value of an engineer was wholly unappreciated and the many fundamentals of engineering that must be a part of every efficient and successful clay products establishment, were closed to the industry because up to within the last 25 years the doors to that avenue of knowledge had been shut. Nearly all of the national associations and many individual manufacturers have recently conducted or are conducting engineering research. Members of the AMERICAN CERAMIC SOCIETY are quite well informed as to the special investigation conducted jointly by the American Face Brick Association, Common Brick Manufacturers' Association, Hollow Building Tile Association and National Paving Brick Manufacturers' Association in coöperation with various federal government bureaus.

Credit is also due our colleges with ceramic departments who have trained

men to think for the industry and to guide it along the lines of modern industrial development. Many men of broad vision and great ability have been given to the clay industry by the colleges.

The other two factors mentioned at the beginning of the article as having a bearing upon the development of the industry—market and competition —are quite inseparable and might better be discussed together.

During the past quarter century we have seen remarkable increase in the use of cement. The production in 1898 of cement in the United States was something like 17,000,000 barrels as compared with 100,000,000 barrels at the present time. It is only natural that this material should make inroads on the clay products industry's market. The competition due to cement and lumber has caused the gradual falling off of production of brick and tile and made it apparent to manufacturers that something must be done to keep the industry before the eyes of the public. Millions of dollars spent by cement and lumber interests in promotional and propaganda work were focusing the attention of the public upon these products with the result that clay ware was being forgotten and business weaned from it.

The inroads of these substitute materials on the business of the clay industry have served as another incentive for keeping production costs low so that prices might be favorable for competition.

To help combat the influences of other materials important developments have taken place in the products of the clay industries. The most important of these is the adaptation of hollow tile to all forms of construction from the building of a private garage to the erection of America's world-famous skyscrapers. Hollow tile is now used as fireproofing in walls, floors (flat arch construction), steel beams and columns, and many other ways. It has found a use in the building of homes, of sanitary and fireproof farm structures, in fact in practically every construction enterprise.

A development in hollow wall construction has created a greater demand for brick and has made it possible to erect a structure with fewer brick and less labor.

Twenty-five years ago there existed one national association in the clay products industry. This was the National Brick Manufacturers' Association and it was composed of men of various interests. Because of this fact, its effectiveness as a trade association was lost and to make up for this deficiency, the members of kindred interests formed associations in their own fields. It so happens that the AMERICAN CERAMIC SOCIETY was the first organization to have split away from the old National Brick Manufacturers' Association. Following this, the paving brick, sewer pipe, face brick, hollow building tile, and common brick manufacturers formed their respective associations. Each of these associations have permanent,

paid secretaries who are especially trained and efficient for carrying on the activities of their respective associations. Among these activities might be mentioned publicity, preparation of hand books, making of scientific tests, compilation of data, aid in establishing better building codes throughout the country; stimulation in the training of more bricklayers, rendering service in better cost accounting methods, standardization of products and countless other activities.

These associations have spent millions of dollars in publicity and promotional work where formerly not a cent was spent. Individually, the manufacturers are also doing similar work and the association has stimulated its members to better business methods.

Years ago secrecy, cut-throat competition and distrust lurked everywhere throughout the industry. This throttle of progress is well shown by referring to government production records. The formation of associations has dispelled much of this feeling, and through coöperation brick and tile is steadily making progress such as is deserved by a product of such excellent service, quality, beauty and permanence.

Much more could be said concerning the text of this article and matters mentioned above might well have been discussed more fully. However, as previously stated, it is obvious that in the space allotted in a single article only a few of the outstanding features can be chronicled.

CHICAGO, ILLINOIS

FIRE-CLAY REFRACTORIES

BY R. M. HOWE[1]

The annual production of fire-clay brick has shown a marked growth during the past 25 years because of the increased demands of the metallurgical industries. Established plants have been enlarged, new plants have been built, and in some cases new districts have been developed. Development has probably been most conspicuous in Kentucky, Missouri, Colorado and California.

Meanwhile, there has been a decided change in the attitude towards certain clays. Burley flint clays that were formerly rejected are now being mined and flint clays of all types are being conserved to the fullest extent. Consequently, fire-clay bricks of low or medium refractoriness have replaced those of higher refractoriness in a number of cases. On the other hand, fire-brick for certain purposes contain a larger percentage of flint clay and in some cases are manufactured from this material alone. In general, the tendency has probably been to omit the use of flint clay whenever possible, but to increase it where operating temperatures are higher.

[1] Industrial Fellow, Mellon Institute of Industrial Research, University of Pittsburgh, Pittsburgh, Pa.

There is no question but that the mining practice has improved during the past 25 years, for clays that were previously accepted are now rejected, while other clays that were formerly rejected are now accepted. The more general practice of drilling in advance of operations and the use of laboratory tests have contributed to the improved mining practice.

Methods of transportation from the mine to the plant have shown a steady improvement, such conveyances as wagons having been almost entirely replaced by overhead trams, narrow gauge railways, or even standard gauge spurs.

Twenty-five years ago most of the clay grinding and mixing was done in a single operation by the wet process. Today there is a decided tendency towards the dry grinding of each clay, followed by screening, and then by mixing. As a result, it is possible to produce a product of more uniform texture and where automatic measuring devices are used the composition is very regular.

The importance of the water content of the mud is more fully appreciated today and more care is used in its measurement. In a number of cases poidometers are being used in controlling the water supply.

Whereas most of the fire brick produced 25 years ago were made by hand, a very large percentage of the present production is machine made. Soft mud machines, auger machines, dry presses, and in one case a sewer pipe press, have been installed for the shaping of fire brick. Meanwhile there has been a strong tendency towards better workmanship, which is often secured by using a finer grind.

Tunnel and humidity controlled dryers have been added to the equipment of many plants. The rectangular kiln has been replaced in a few cases by round or even continuous kilns. The rectangular kiln is not as economical in fuel as those of the other types, but it is favored where a large number of special shapes are produced. On the other hand, the round kilns are adapted to the burning of standard fire brick and do so at a saving in fuel. Consequently, the kiln equipment of many plants is controlled by the nature of their product. The use of continuous kilns has been retarded in a great many cases by the lack of sufficient space for expansion as plants are often built in decidedly restricted areas. Regardless of the type of kiln there has been a decided tendency towards harder burning.

There has been a marked improvement in the use of refractories during the past 25 years. In some cases the character of the clay refractory has been altered, while in other cases a different type of material has been substituted. The substitution of silica brick for those of fire clay has been the most noticeable and this has resulted in economy to the user as well as in the conservation of flint clay.

Considerable progress has been made during the past decade in the standardization of refractories. Mr. A. V. Bleininger proposed a set of specifi-

cations covering quality (1918), and these were promulgated through the War Industries Board (1918). They were later accepted by the American Society for Testing Materials (1920) and the Refractories Manufacturers' Association (1921).

The work of the standardization committee of the Refractories Manufacturers' Association has been very successful in reducing the number of standard sizes and shapes. This committee found that some 75 so-called 9-inch sizes (including arches, wedges, keys, etc.) were being used in conjunction with standard $9'' \times 4^1/_2'' \times 2^1/_2''$ straights. After an enormous amount of investigation and study it was found that this number could be reduced to 29, and these 29 shapes are now filling nearly every need formerly filled by the larger number. The resulting economy scarcely needs discussion, for it is evident that the cost of production was greatly reduced, while the problem of carrying a complete line of standard shapes was greatly simplified. As a result, it is now possible to give the consumer better service at a lower cost.

MELLON INSTITUTE OF INDUSTRIAL RESEARCH
UNIVERSITY OF PITTSBURGH
PITTSBURGH, PA.

CHROME REFRACTORIES

BY J. SPOTTS MCDOWELL

The first recorded experiments with chrome ore as a refractory were made in open-hearth furnaces in France in 1879; it was used on a large scale in the following year in an open-hearth plant at St. Petersburg. At this plant, crushed chrome ore was used to separate the dolomite bottoms from silica brick. A few years later chrome ore was adopted as a hearth material at several European open-hearth plants, but was supplanted by dead-burned magnesite, which was found to be much more satisfactory.

The use of chrome ore for refractory purposes in the United States began about 1896, when the Harbison-Walker Company began the manufacture of chrome brick. It has gained an important place as a refractory material by virtue of its chemically neutral character and its high refractoriness. It is marketed in the form of brick and of ground unburned chrome ore.

Only a few companies in the United States make chrome brick. These are the Harbison-Walker Refractories Company at Chester, Pennsylvania; Federal Refractories Company, Alexandria, Pennsylvania; American Refractories Company, Baltimore, Maryland; General Refractories Company, Sandy Ridge, Pennsylvania; Lavino Refractories Company, Plymouth Meeting, Pennsylvania.

Chrome brick have always been made very much like magnesia brick.

A bonding material, such as clay or lime, was formerly used but this is no longer done. The brick are now molded in a power press semi-dry, dried in tunnel dryers and burned in rectangular down-draft kilns at an extremely high temperature.

For many years prior to the War, all the chrome used in the refractories industry was imported. The most important deposits are those of New Caledonia, Greece, Turkey, South Africa and India. During the War the demand for the ore was great, and prices became sufficiently high so that California and Oregon ores could be profitably shipped to the eastern industrial centers. Notwithstanding the high cost of transportation imports reached a high figure. Nearly all the ore, however, was needed for metallurgical and chemical purposes and the manufacturers of refractories were able to obtain only a limited amount. At the end of the War the demand fell off, prices dropped, and little or no ore is now being produced in the United States. Imports are coming mainly from South Africa, New Caledonia, India, Greece and Turkey.

In the basic open-hearth furnace the use of a neutral course of chrome brick between the acid and basic portions of the structure is considered good practice. Much ground chrome ore is consumed in patching, daubing, and facing the walls of open-hearth furnaces. On account of its slag resisting qualities chrome has been found to be excellently adapted for the lining of certain parts of such furnaces as soaking pits, heating and heat treating furnaces, forge and welding furnaces, copper settlers and copper refining furnaces.

A review of the literature concerning chrome ore and chrome refractories has been given in the December, 1922, issue of this *Journal*.

HARBISON-WALKER REFRACTORIES COMPANY
PITTSBURGH, PENNSYLVANIA

TECHNICAL DEVELOPMENTS IN DOLOMITE REFRACTORIES

BY H. G. SCHURECHT

Sintered dolomite is at present used chiefly for patching magnesite furnace linings since it sets quicker than magnesite when thrown in a hot furnace. Dolomite is not used extensively for new linings since it is not as resistant to slagging action as magnesite and the linings made of dolomite often disintegrate to a powder when the furnace is shut down for long periods. Sintered magnesite is more stable in these respects and, therefore, is preferred for new linings or for patch work when the furnace is shut down. Dolomite, however, is indispensable for patch work while the furnace is in operation.

The comparatively low price and wide distribution of dolomite have stimulated efforts to substitute it for the more costly and less abundant

magnesite. It is very difficult to place dolomite in a "dead-burned" condition owing to its high lime content which causes the calcined product to disintegrate upon storage owing to the unstability of free lime and certain lime compounds which are formed upon calcination. The major portion of the research on dolomite refractories has, therefore, been confined to determining the best methods for rendering dolomite "dead-burned."

The most common method for dead-burning dolomite is by mixing an impurity with the ground material and calcining the mixture at a high temperature.

Numerous patents have been issued and some research has been done[1] on this method of dead-burning dolomite. The following impurities were added: silica, iron oxide, roll scale, flue dust, alumina, chromium oxide, manganese oxide, sodium chloride, kaolin, bauxite, blast furnace slag and basic open hearth slag. The highly aluminous fluxes produced the most stable product since lime combines readily with alumina. Fluxes high in iron produce a product which has considerable free lime owing to the fact that iron oxide does not combine readily with lime and, therefore, the calcine disintegrates upon storage due to slaking. Although highly siliceous, fluxes combine readily with lime they form the unstable calcium orthosilicate, $2\ CaO.SiO_2$. In cooling the beta calcium orthosilicate changes to the gamma form at 675 °C with an increase in volume of 10 per cent. This volume change shatters the material into fine dust in spots often breaking off big pieces of the sintered dolomite.

Such "dusting" may be prevented in the manufacture of dolomite brick by using fluxes low in silica. Silica may, however, combine with the dolomite from the slag and impurities during its use in a furnace. It is difficult to state how vigorous such a reaction would be at present but if very serious the only possible method for utilizing dolomite for refractories would be to separate the lime and use only the magnesia thus prepared.

The separation of magnesia from dolomite may, therefore, become important in the utilization of dolomite for refractories. Numerous methods of separating magnesia from dolomite have been developed. This was done by treatment with $MgCl_2$,[2] with CO_2 under pressure,[3] by calcining dolomite at 500–600 °C and washing out the MgO,[4] by dissolving the lime

[1] Davison, G. L., U. S. 792,382, June 20, 1905. Stowe, C. B., U. S. 1,205,056, Nov. 14, 1916. Handy, J. O. and Isham, R. M., U. S. 1,270,818, 1918. Newberry, S. B., U. S. 1,267,686, May 28, 1918. Jones, Fred. A., U. S. 151,535, Jan. 1, 1918. "Experiments in Deadburning Dolomite," *Jour. Amer. Ceram. Soc.*, **2**, 291–305 (1919). "Experiments in Deadburning Dolomite and Magnesite," *ibid.*, **4**, 127–151 (1921).

[2] Scherer, R., "Der Magnesit A. Hartleben's Verlag," Wien und Leipzig, 84, 1908.

[3] "Der Magnesit," *loc. cit.*, 134.

[4] "Der Magnesit," *loc. cit.*, 134; Mitchell, A. M., "Process for Obtaining Magnesium Oxide from Dolomite," U. S. 1,273,110, July 16, 1918.

with a sugar solution,[1] by treatment with $MgCl_2$ and NaCl with an excess of NH_4Cl,[2] by leaching the calcined dolomite with water,[3] by a H_2SO_4 treatment,[4] by flotation, leaching and screening and elutriation.[5] It is possible by most of these treatments to obtain a product containing 75–95 per cent magnesia. Whether they can be employed will depend upon the cost of separation and the future price of magnesite.

Although granular dolomite is now successfully prepared, dolomite brick have not yet been manufactured commercially which will stand prolonged storage. This is largely due to the fact that it is difficult to bond them successfully. Heretofore tar has been employed as a binder since it is anhydrous and hence will not slake the free lime. Recently the writer has successfully used sulphate solutions for tempering dolomite brick. By means of these solutions the free lime is converted into the insoluble sulphate thus allowing the brick to be tempered, molded, dried and burned without danger of slaking. After the brick have been fired, they may again be dipped in a sulphate solution and stored indefinitely without danger of slaking. $MgSO_4$, $7H_2O$ and Na_2SO_4 solutions gave better results than $FeSO_4$ or $Al_2(SO)_3$ solutions.

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MAGNESITE REFRACTORIES

BY J. SPOTTS MCDOWELL

Introduction

The following notes on the technology of magnesite refractories are given in order to add clearness to the historical sketch. The raw material of the industry is the mineral magnesite, $MgCO_3$, theoretically containing 47.6% MgO and 52.4% CO_2. Two types are to be distinguished: the dense and the crystalline. The dense variety is usually snow-white in color and often of high purity; while it usually contains little lime or iron, the presence of several per cent of silica is not uncommon. The crystalline variety is finely to coarsely crystalline and of variable color; it is not often extremely pure, but usually contains slight admixtures of lime, iron and silica. Except for a period during the War, the crystalline magnesite almost exclusively has been used in the manufacture of refractories.

[1] "Der Magnesit," *loc. cit.*, 135.

[2] Bradburn, J. A., "Process of Obtaining Magnesia," U. S. 1,156,662, Oct. 2, 1915.

[3] "Refractory Material and Process for Making Same," U. S. 1,270,819, July 2 ,1918.

[4] Newth, G. S., A "Text Book of Inorganic Chemistry," Longmans, Green & Co., New York, 575, 1905.

[5] "The Separation of Lime from Dolomite," *Jour. Amer. Ceram. Soc.*, **4**, 558–569 (1921).

The first step in the preparation of magnesite products is selection at the quarry, involving about 50% waste; after that comes calcination of the crude mineral, in order to drive off more or less completely the carbon dioxide with which the magnesia is chemically combined. "This treatment causes a loss of about 50% in weight, a considerable decrease in volume, and marked changes in physical properties. The character of the resultant product is dependent upon the time and temperature of calcination, and the amount and character of impurities present."[1] Magnesite which has been calcined at a comparatively low temperature, 800° to 1000°C, is known as "caustic burned magnesia," and is prized as a structural material on account of its setting and cementing properties when mixed with a solution of magnesium chloride.

"Dead-burned magnesite" results from calcining the mineral at a temperature sufficiently high not merely to drive off nearly all the CO_2, but also to cause sintering of the particles. The product is hard, dense and inert to atmospheric moisture and CO_2. The temperature at which this occurs depends upon the texture and composition of the crude magnesite. One high in iron oxide such as the Austrian, will frit together at 1450°C to 1500°C, while a temperature of 1600° to 1700°C, or higher is required for one low in iron oxide and other impurities. For this reason a small percentage of iron oxide is considered necessary for the production of dead-burned magnesite for refractory purposes. Dead-burned magnesite is marketed in the form of a mixture of nodules or grains varying in size from pieces about $^5/_8$-inch in diameter to very fine particles. It is used for the construction of monolithic hearths in furnaces, and for the manufacture of magnesia brick. The chief value of both the grains and the brick lies in their chemically basic character and their high refractoriness.

Historical Sketch

Twenty-five years ago magnesite had just begun to assume industrial importance as a refractory, on account of its value as a hearth material in the open-hearth process for making steel. This process, which was destined to revolutionize the steel industry, had been introduced abroad in 1879, and had been first adopted commercially in this country by Carnegie Phipps and Company, at Homestead, in 1888.

The first experiments on magnesite furnace bottoms for the open hearth were made abroad in the early eighties. The material utilized was dead-burned grains prepared from the non-crystalline Grecian magnesite. This did not sinter together properly and patches of the bottom sometimes became detached and floated in the molten steel. The addition of fluxing impurities such as clay gave the magnesite a stronger bond,

[1] McDowell and Howe, "Magnesite Refractories," *Jour. Amer. Ceram. Soc.*, **3**, 185 (1920).

but at the expense of its refractoriness. It was finally learned that a crystalline magnesite from the province of Styria, Austria, had the property of readily sintering into hard dense pieces, without fusion. This was attributed to its high content of iron, which amounted to about 7% Fe_2O_3 in the dead-burned grains. Brick made of the dead-burned material were hard and strong and highly refractory; and open-hearth bottoms made of it were highly resistant to the action of slags and the erosion of molten metal. As a consequence the Austrian magnesite had almost completely replaced all others as a refractory material early in the present century, and maintained this supremacy until the beginning of the World War.

The first industrially successful use of magnesite in the bottoms of open-hearth furnaces in the United States was probably that of the Wellman Steel Company, at Chester, Pennsylvania, in 1891.

With the rapid growth of basic open-hearth steel production in the United States during the present century, the consumption of magnesite refractories has greatly increased. The principal application of magnesite is still in the basic open-hearth furnace, but it has become an important refractory for electric heating and welding furnaces in the steel industry and for various furnaces in the metallurgy of copper, lead, and nickel.

A highly important development of recent years has been the complete replacement of siliceous linings by magnesia linings in copper converters. This change has brought about the use of much larger converters, has cheapened converting costs, and has done away with the necessity for continually relining the shell. The siliceous linings were consumed by the iron of the matt, and were usually good for only 20 to 50 tons of matt. In a basic lined converter a record has been attained of over 85,000 tons of matt charged before it became necessary to shut down for repairs.

The first commercially successful results obtained with a basic lined converter were those of Peirce and Smith in 1909. They developed the Peirce-Smith converter, which is a horizontal barrel-shaped vessel. In 1911 the Anaconda Copper Mining Co., developed the vertical Great Falls type converter. These types have proved about equally popular in American smelters.

In 1894 the Fayette Manufacturing Company first manufactured magnesia brick at Layton, Pennsylvania, using calcined Grecian magnesite to which a small amount of iron ore had been added. About 1895 this company began the importation of the Austrian magnesite, which it thereafter used almost exclusively, and in 1902 began the erection of a plant at Chester, Pennsylvania, to be devoted to the manufacture of magnesia brick. At that time nearly all of the Austrian magnesite was supplied by the firm of Carl Spaeter, and was therefore known as Spaeter magnesite.

From 1898 until 1902 Harbison-Walker Company at Pittsburgh made

magnesite refractories from Austrian and from Grecian magnesite by a process like that of the Fayette Manufacturing Company. In 1902 the Harbison-Walker interests obtained control of the Fayette Manufacturing Company and from that time on the Austrian magnesite dominated the field of basic refractories in the United States. At the present time magnesia brick are made at the plants of the Harbison-Walker Refractories Company, Chester, Pennsylvania; American Refractories Company, Baltimore, Maryland; General Refractories Company, Sandy Ridge, Pennsylvania; Federal Refractories Company, Alexandria, Pennsylvania; and Lavino Refractories Company, Plymouth Meeting, Pennsylvania.

The first magnesia brick of American manufacture were made by the hand-made process and dried on the hot-floor. They are now manufactured by the semi-dry process in a Boyd or other power-press, dried in tunnel dryers, and burned at a very high temperature in rectangular down-draft kilns. The brick are made from 100% dead-burned magnesite, with no bonding material.

A special form of magnesia brick used in open-hearth and electric furnaces was devised in 1914 and is known as "metalkase brick." These brick consist of round or square steel containers, open at the ends and of a convenient size for handling and laying, packed with dead-burned magnesite.

Prior to the World War, America had been wholly dependent upon Austria for refractory magnesite. The material was calcined abroad near the deposits and shipped to this country in the form of the dead-burned grains. The grain magnesite was marketed as received for use in furnace bottoms or used in the manufacture of brick.

At the beginning of the War, imports from Austria were suspended and the refractory manufacturers were placed in a most difficult position. Domestic deposits had not been sufficiently developed; American calcining facilities were utterly inadequate; and the magnesite available was low in iron and lacked the bonding properties of the Austrian material. The situation was met by the importation of Grecian and Canadian magnesite; the exploitation of American deposits; and the erection of calcining plants and utilization of existing cement or brick kilns for calcining. At some of these plants the raw material was merely calcined to drive off the CO_2; at others the crude or lightly calcined material was mixed with a small percentage of iron ore and dead-burned in rotary or brick kilns at a high temperature.

During the War, sintered dolomitic refractories were developed, and used considerably as substitutes for dead-burned magnesite for furnace bottoms, although not for brick. These dolomitic preparations have been largely replaced by magnesite since the latter again became available in sufficient quantities.

During the early part of the War, the main supply of magnesite came from Greece; in 1917 shipments from this source were likewise suspended. Considerable magnesite was shipped to the United States from the Grenville district, Quebec. This material was not considered desirable on account of the high lime content, and imports from Canada gradually diminished as the American deposits were developed.

For many years it had been known that California contains numerous deposits of the non-crystalline type of magnesite in veins and lenses, usually small. The most important areas are the Portervilla district in Tulare Co., and St. Helena, Napa Co. Prior to 1914 about 10,000 tons of crude magnesite were being produced annually of which little, if any, was used for refractory purposes. In 1915 the California output jumped to over 30,000 tons, due to the shortage caused by the War. By 1917 the production had grown to over 200,000 tons, but dropped in 1918 and 1919 to about 84,000 and 60,000 tons, respectively, due to the development of the Washington deposits. Most of the magnesite shipped to the eastern seaboard early in the War was in the crude condition; later as calcining kilns were erected, it was shipped principally in the calcined but not dead-burned form. Calcining was done in bottle-shaped and vertical shaft kilns and in rotary kilns. Upon its arrival in the east this material was dead-burned with the addition of iron.

In 1916 large deposits of crystalline magnesite were discovered in Stevens Co., Washington, and shipments began on a large scale in the following year. The known deposits contain several million tons of high grade magnesite. The most important deposits were acquired by two companies, the American Mineral Production Co., and the Northwest Magnesite Co. In 1918 the latter Company erected a modern plant near Chewelah, Washington, for the production of dead-burned grain magnesite. Six rotary kilns have been installed, with an annual capacity of over 100,000 tons of dead-burned material.

In the latter part of 1920 imports of magnesite from Austria were resumed. This was delivered to the eastern steel centers at a lower price than could be met by the American product, on account of the high transportation costs across the continent. In December, 1920, the Northwest Magnesite Company suspended operations and has been idle since.

In the 1922 tariff bill a duty was imposed on dead-burned grain magnesite and magnesia brick. What effect this will have in stimulating domestic production has not yet developed.

During the last twenty years and particularly during the War period various studies by independent investigators have been made of physical and chemical properties of magnesite refractories. These have been summarized in a paper published in the March, 1920, issue of this *Journal*. Among the most interesting of these investigations are the microscopic

studies of dead-burned magnesite and of magnesia brick. It has been shown that in the burning process the iron oxide combines only slightly, if at all, with the other impurities present, but that it enters into solid solution with the crystals of periclase (MgO), and also combines with MgO to form the mineral magnesioferrite. The latter separates out as minute inclusions within the periclase granules. The value of the proper proportion of iron in magnesite evidently lies in its catalytic action in hastening the formation of periclase crystals from the amorphous MgO, which is the first product of calcination. The lime and silica impurities form silicate minerals, evidently of the olivine group, by combining with the necessary amount of magnesia. Forsterite, $2MgO.SiO_2$, has been identified under the microscope by several observers.

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TECHNICAL DEVELOPMENT IN THE FIELD OF SILICA REFRACTORIES DURING THE PAST TWENTY-FIVE YEARS

BY E. N. MCGEE

Early History of the Silica Refractories[1]

Among the earliest known silica bricks are those used in the four striking panels from the celebrated frieze of arches in the Palace of Darius (500 B.C.) now in the Louvre, Paris. These are shown by Bigot to consist of 90% quartzose sand with 10% lime for bond. The same authority has expressed the opinion that they were burned at about 1200°C. They absorb 12% water and are quite refractory though readily glazed. Their refractoriness is incidental, however, as they were used exclusively by the Persians for mural decorations.

Early Development in Europe

The first use of silica brick in Europe was apparently a gradual development due to the demand for a refractory which would withstand higher temperatures without softening under the loads which they had to carry. The character of the clay bricks first manufactured made them unsuitable for withstanding the very high temperatures produced in the furnaces necessary to meet the improved methods of smelting ores and metals. Highly siliceous rocks were then tried, such as pudding stone, granite, Dinas and other quartzites. These were found to be better in some ways but still unsatisfactory. An improvement was then made in the first type of open-hearth furnace by using a lining of siliceous clay which paved the way for the introduction of bricks made from grinding siliceous rocks and bonding with a small percentage of lime or plastic clay. Silica brick were

[1] From "Refractory Materials" by A. B. Searle.

first manufactured in Europe in 1822 by W. W. Young, from Dinas sand, found in the Vale of Neathe in Wales, and sold as Dinas bricks. Their manufacture was also started by the same man in Sheffield in 1858.

Early Development in the United States

Although the manufacture of clay bricks appears to have been introduced in America about 1825, the industry growing and spreading very rapidly, there does not appear to have been any silica brick manufactured until about 1887. These bricks were made at the Star works, now known as Harbison and Walker, and competed successfully with the Dinas or Welsh brick which up to that time had been almost exclusively used in this country. In 1906, the American Refractories Company was incorporated and were the second company to attempt the manufacture of silica brick on a large scale. Thus the beginning of this industry falls within the twenty-five year period and consequently the story of its development covers its progress from the beginning until the present time.

Development in the Field of Silica Refractories

The story of the development of the silica brick industry is very closely related to that of the developments in the metallurgical and by-product coke industries. In fact, the silica brick manufacturer is practically dependent upon these industries for existence. Since the by-product coke industry is to a large extent dependent upon the iron and steel trade, which is by far the most important of the metallurgical industries, it is therefore logical to infer that the output of silica brick is mainly dependent upon business conditions in the iron and steel industry.

Metallurgical Industries

During the past twenty-five years the uses for silica brick have been developed to such an extent that they are now common in the arches, crowns and higher parts of nearly all furnaces and kilns connected with the iron, steel, copper and other metallurgical industries. In blast furnaces they are used because of their ability to sustain a heavy load at high temperatures without shrinkage or warpage. In open-hearth and electric furnaces of all kinds they are used for roofs since they combine the qualities of lightness and refractoriness, and are not materially affected by the chemical action of the vapors. They are used for lining all acid furnaces and usually for linings of crucible furnaces. The roofs and linings of roasting furnaces are also sometimes constructed of this material. They are also generally used in heat-treating furnaces and in the hottest parts of gas-fired furnaces and kilns, including the reverberatory furnace. Formerly checker-work of the open-hearth and reverberatory regenerators, blast furnace stoves

and bustle pipes, was built of clay brick but it was found that silica was much more satisfactory. Silica brick are less readily chocked up and do not fuse or vitrify, consequently they give several times the life of a clay brick. Clay brick are usually used in checker-work installations, only for a few bottom courses which are subject to spalling.

The use of silica brick in cupolas is rather uncommon but in some cases it has been found satisfactory. Four or five courses of silica are laid in the melting zone of the cupola, using silica cement to give a tight joint. Ladles are also sometimes lined exclusively, except the top courses, with silica brick. They spall if heated too rapidly on the first pour but after that they can be handled the same as a clay-lined ladle, apparently due to the fact that the brick become slightly glazed.

By-Product Coke Industry.—Silica brick were first introduced in by-product coke oven construction at Johnstown, Pa., in 1899 in some ovens of the Otto-Hoffman type. The Semet-Solvay Company next introduced their use about 1906 and the Koppers Company followed shortly afterward. In this industry as in the metallurgical field, the use of silica brick was a gradual development. Clay brick were unsatisfactory because they softened and shrunk if the operating temperature was carried much above 1200°C. Quartzite brick, or what in England were called Canister brick and in Germany, German Dinas brick, were next tried. These bricks were highly siliceous in character, approximately 80% SiO_2, and were used for the purpose of eliminating the injurious shrinkage which was so prevalent with clay brick due to the heavy loads which had to be carried. The introduction of silica brick in coke oven construction, however, practically eliminated the use for quartzite brick since these bricks not only solved the shrinkage problem but also stood up at a considerably higher temperature without failure under load and consequently they paved the way for the present coking practices. Instead of requiring from twenty-four to thirty hours to coke a charge of coal in an oven sixteen inches in width, a charge is now coked in an eighteen-inch oven in sixteen or eighteen hours without injurious results to the oven. The expansion characteristics of silica brick are also an added factor in their favor because of the tendency to make tight joints; even the cracks which are opened up when an oven is cooled down for repairs are closed up again after heat is applied, because of this expansion. It is only necessary to leave sufficient expansion joints to take care of any excessive expansion which might otherwise injure the entire structure.

By-product coke ovens are now, almost entirely built of silica brick from the matt to the roof. Clay brick are used in the lower courses of the checker-work of the regenerators, as veneering on the outside and sometimes in the bottom flues to act as a sort of buffer against rapid temperature changes which would be detrimental to the silica brick. Clay brick are

also used in the roof structure where they are not subjected to sufficient heat to cause any injurious shrinkage. When it is considered that approximately the equivalent of 45,000 nine-inch silica brick are required for a single oven, the importance and influence of the modern by-product coke oven industry on the manufacture of silica brick is plainly evident.

Gas Retorts.—The use of silica brick in gas retorts is a common practice and is due to the same factors which have influenced its use in the by-product coke oven.

Glass Furnaces.—The glass industry, which has developed rapidly during recent years also uses a considerable quantity of silica brick in the arches, crowns and higher parts of the furnaces connected with the manufacture of glass.

Lime Kiln Linings.—Silica brick are now being used to some extent for lime kiln linings in the hot zone where they are not subjected to rapid temperature changes. Their use here is possible if the temperature at which the limestone is calcined is not sufficiently high to cause the silica and lime to combine. They have proved successful for this purpose because of their resistance to the erosion caused by the passage down the kiln of the hot and somewhat plastic lime charge.

Beehive Coke Ovens.—Silica brick have also been tried in the beehive coke oven crowns and proved more satisfactory than clay brick. They are used here under conditions which would seem detrimental to their success, because the intermittent use of the beehive oven causes spalling and cracking of oven clay brick. The reason that silica brick can be used in such a construction is no doubt due to the fact that the expansion of the silica and taper of the brick tend to retain the pieces in the dome. It has also been noted, however, that after the brick have been subjected to the operating conditions a short time they become slightly glazed and do not spall as readily as when first put into operation.

Boiler Furnaces.—Silica brick are rarely used in boiler furnaces on account of the inability to withstand rapid temperature changes but they have been tried successfully in a few cases where they were protected from drafts, and where the heating was gradual and the boilers were not forced. In such constructions they outlive clay brick and are free from clinkers. If, however, the boilers were forced, necessitating the use of very high temperatures, the coal ash would no doubt cause injurious fluxing of the silica brick.

Development in the Manufacture of Silica Brick

Although the silica brick industry started in the United States with over fifty years of European experience as a foundation, still the requirements of the three principal industries involved in its growth, the steel, by-product coke, and glass industries, were of such a character that a better

grade of brick was necessary than in European practices. It was only through research investigations, principally carried on by the manufacturers themselves, that bricks of a suitable quality and workmanship were obtained to meet these requirements.

The manufacture of silica brick has not varied greatly since the first few years of its introduction in this country, the progress being mainly toward greater capacity and increased output. It is not the purpose of this article to discuss manufacturing processes only insofar as they indicate development in the methods of manufacture. Surface flow rock was used exclusively in the beginning but solid measure or quarried rock has since been found just as satisfactory. Lime bonded brick were found to meet the requirements best and the limits, as first determined, of 1.5% to 3.0% lime, still prevail. In the hand moulding of silica brick there are two processes, known as semi-dry or stiff mud process and slop mud or what is sometimes called the Anaconda process. For shape moulding the stiff mud process is always used in order that the large or difficult shapes may hold together until dried without squatting. This mud must be pounded and worked into the moulds. Steel moulds are now used exclusively and, in the case of standard sizes, at least six are grouped together so as to make that many brick in one operation. For shape moulding, wooden box moulds are used with steel liners which are made in sections. The wooden box is first removed and then each section of the liner is carefully pulled away from the brick. Machine moulding of standard nine-inch brick presents a problem which has received considerable attention during the past few years, but it is not yet entirely out of the experimental stage. The characteristics of silica mud make it much more difficult to handle than clay brick mud in machine moulding. It has been a slow process perfecting the operation so that the moulds will always be completely and uniformly filled, and so that there will not be long and costly shut-downs for repairs. Machine moulding of standard nine-inch brick is, however, proving successful in at least one plant and will no doubt become common practice within a few years as it means greatly increased production with less labor.

After the brick are moulded, the standard shapes are placed on rack cars and run into tunnel dryers heated by waste heat from the kilns while the shape brick are dried slowly on the hot floors. The brick must be thoroughly dried before being placed in the kilns for burning. The kilns are usually round kilns of the down-draft system fired with coal, and will hold (depending upon their size) anywhere from 100,000 to 150,000 nine-inch brick. The setting and burning of the kiln requires great care and it is necessary that the maximum temperature reached be approximately 1500°C to insure a proper bond, complete expansion and a hard, tough structure.

Effect of World War and Coal Strike of 1922 on Silica Brick Manufacture

The World War and the coal strike of the past year both had, to some extent, injurious effects upon the manufacture of silica brick. During the War the demand for brick exceeded the production capacity. The attempt to meet this demand, with the shortage in skilled labor a constant drawback, resulted in the production of brick, and especially shape brick, which were below the normal standard, not in quality of materials but in workmanship and structure. The coal shortage during the past year has also had an injurious influence due to the fact that most of the coal which could be obtained was not up to the quality required for the proper burning of silica brick. The effect of these two influences upon most of the consumers has been to make rigid inspection a necessity in order to obtain the quality and workmanship necessary to meet their demands.

Effect of the War upon Research Investigation

The War has also had a very gratifying effect upon the development of the silica brick industry in that it occasioned the necessity for considerable research work to obtain complete information concerning the manufacture and especially the properties of these materials to determine their fitness for various new and improved operations. The enormous increase in the demand for all kinds of products during the War meant production above normal capacity. Where furnaces were used in their manufacture it meant pushing them to the limit with the result that failures occurred much more rapidly than during normal operations. Consequently, came the demand for better refractories and research work was started by a great many manufacturers to determine the proper selection of refractories for various purposes. Thus the testing of refractory materials has become common and methods have been standardized which place their proper selection upon a well-developed technical basis.

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HIGH ALUMINA REFRACTORIES

BY J. L. CRAWFORD[1]

High alumina refractories may be divided into two classes: That in which the aluminous material is electrically treated at a temperature higher than those of an industrial kiln during the process of manufacture, and that in which the raw material is not electrically treated, such as bauxite, diaspore and aluminous fire-clay refractories. It is the purpose of this paper to deal with only the latter class of refractories.

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There have been some very remarkable developments in high alumina refractories during the past twenty-five years.

Fire clays containing over 40 per cent Al_2O_3 are found chiefly in Pennsylvania, Missouri and Kentucky. In Clearfield and Center counties in Pennsylvania there is found a rough flint clay containing a large number of nodules high in alumina which analyzes 40 to 55 per cent Al_2O_3 and by proper selection a clay containing as high as 60 per cent Al_2O_3 can be obtained. In central Missouri there are a large number of "pockets" of burley flint clay analyzing from 40 to 60 per cent Al_2O_3. Both of these deposits have been worked to a considerable extent during the past twenty-five years. High alumina clays have been reported in Kentucky, but are of small quantity and have never been separated from the run of mine. Refractories have been made from these clays which have given very good service in resisting high temperature and particularly in resisting slag action in furnaces used in the metallurgical and ceramic industries. Probably the most progress has been made in developing refractory liners for cement and lime kilns.

The tonnage of bauxite refractories produced annually has never been large as compared with other refractories. The difficulty in removing the fire shrinkage in bauxite refractories has been one of the chief drawbacks of this refractory. Bauxite refractories were being used to a considerable extent in furnaces operating at high temperatures and in contact with basic slags until recently, when they were almost entirely replaced by diaspore refractories.

Diaspore refractories are equally as refractory and resistant to basic slag and they have a very low fire shrinkage.

The supply of diaspore is rather limited as the only known deposits of workable size in this country are those in central Missouri district where it is found in "pockets" with the flint clay.

In 1908 a St. Louis refractory manufacturer made a brick containing a considerable quantity of the diaspore found in the flint clay pits. This brick gave very good service and in 1914 they made a diaspore refractory analyzing 78 to 80 per cent Al_2O_3. This refractory had a fusion point of cone 37 to 40, making it well suited for high temperature work. The demand for this refractory rapidly increased and in 1920 it had almost entirely replaced bauxite. The development of diaspore refractories has been one of the outstanding features of the refractories industry during the past twenty-five years.

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DEVELOPMENTS IN THE MANUFACTURE OF REFRACTORIES OF FUSED ALUMINA

By M. F. Beecher

The manufacture of refractory articles of fused alumina was begun in this country in 1906. Prior to that time there had been some experimental and development work done in Europe, but first-quality articles had not been produced on anything approaching a commercial scale. This early work on both continents had for its object not only to make refractories, strictly speaking, but also to produce better and cheaper apparatus for the analytical laboratory. Probably because greater difficulties were encountered in making and marketing the former, it was the ceramic bonded, fused alumina laboratory ware (known by the trademark "Alundum") that first became a commercial product in this country.

Up to and including the year 1908 the stock articles manufactured consisted of laboratory crucibles, filter dishes, filter plates and combustion boats. Following this was the introduction of pyrometer tubes and cores, tubes and muffles for wire-wound resistance type electric furnaces. Here is the introduction of the first refractories; *i. e.*, pyrometer tubes and such tubes and cores as are used for high-temperature furnaces wound with platinum or molybdenum.

During the next decade no very extensive commercial developments are recorded. The variety in shape and application of fused alumina articles multiplied rapidly, but it was confined quite largely to laboratory shapes and to small specialties for use in electric appliances. Fused alumina cements ("Alundum" cements) were developed early during this period.

A review of the patent literature during these years indicates a very active interest on the part of inventors. Mention of a few of the patents will serve to indicate that the general trend of these developments was towards adapting bonded fused alumina to new uses and towards the development of new and improved bonds. In the first class may be cited the patents to Jeppson on a refractory cement and on a glazed crucible; to Malm on a pyrometer tube and on a glazed refractory article; to Boeck on a filtering apparatus, a filtering medium and a wire-wound electric furnace construction; to Coolidge on an electric furnace construction. In the second class are the patents to Allen on an alumina bonded fused alumina article; to Saunders on a bondless article in which the mass of fused alumina grains is electrically sintered; to Hall on a cast fused alumina article; to Dentsizen on a bondless alumina article sintered in a molybdenum-wound furnace; to Chappell on an alunite alumina article either with or without a ceramic bond; to Botho Schwerin on a fused alumina article bonded with finely ground fused alumina.

Thus far all the articles marketed were made from high-purity fused alumina (99.0%+) bonded with carefully selected light buff or white

burning clays. A nearly white color, accuracy of dimension and neatness of finish were demanded by the trade. These things naturally operated against the development of large or heavy shapes for strictly refractory uses by keeping the cost at a prohibitive figure.

In the earlier years, between 1907 and 1910, the Norton Company of Worcester, Mass., and Niagara Falls, N. Y., did extensive work in the attempt to develop heavy refractories such as bricks, furnace shapes, slabs, etc., using a lower grade of fused alumina (92 to 94% Al_2O_3), but the results did not lead to commercial production. This can probably be attributed to two principal causes: first, the high cost of the bricks produced; and second, the lack of a sufficient demand for a refractory of exceptionally high quality. The work of that period demonstrated satisfactorily the advantages of the product in places where high softening point, high thermal conductivity, chemical stability, and good mechanical strength are required and where basic slags are absent.

As a result of the growing demand for refractories of better quality which developed during the years 1914 to 1920, the same company in about 1918 picked up again the threads of their earlier experimental work. With a greater demand for better refractories and improved methods for the manufacture of both the fused alumina and of the bonded article, commercial production now seemed more likely to be realized. In this present period of development some very encouraging results have already been attained. It will be interesting to recount a few of these to illustrate the quality of product that is now produced.

Muffle sections for a Dressler tunnel kiln made of bonded fused alumina have now been in service for five months with apparently entire satisfaction. The kiln has not been shut down, so no close examination has been possible. This kiln operates at cone 12, the temperatures within the combustion chamber being from 1275 to 1325°C.

Saggers in the $10^1/_4 \times 4^3/_4$-inch size have been used at cone 12, giving an average life of 40 fires per sagger. Under the same conditions the best clay saggers show a life of 8 fires. Although bonded fused alumina is not especially resistant to thermal shock, this record was made in an 8′ coal-fired kiln which is regularly set, fired, cooled and drawn in six days.

Fire bricks of bonded fused alumina show no deformation in the standard load test at 1350°C under a load of 50 pounds per square inch. Very satisfactory results of an experimental nature have been obtained with these bricks in the roof of an electric steel furnace. A life of 22 heats or 88 hours' total service has been reached with a probability of its running over 30 heats before replacement.

The improvements in product and process which have taken place since 1906 have been largely in better control and in adapting the molding process to the character of the mixture and the shape of the piece. The

crystalline character of the fused alumina is now maintained at a definite standard. The use of accurate and reliable pyrometric equipment in the kilns makes it possible to regulate the firing treatment according to a definite curve. Whereas the articles first made were formed mostly by casting and dry pressing, it is now regular practice to form some articles by hand pressing in plaster molds, by jiggering and even by extrusion through an auger or plunger machine.

The progress of the last few years has been very encouraging, and it seems safe to assume that the next few years will see even a greater field of usefulness for fused alumina refractories.

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ZIRCONIA REFRACTORIES

BY MARK SHEPPARD

ABSTRACT

1. Outline of physical properties of zirconium ore.
2. Mention of zirconia laboratory ware and method of manufacture.
3. Manufacture and physical properties of zirconia brick.
4. Zirconia cement and its uses.

The discovery, in 1899, of a large deposit of natural zirconium oxide in the Caldas region of Brazil led to considerable research in the development of uses for zirconium oxide. The most important of these are in production of ferro alloys and special refractories.

The fusion point of zironia containing 99% of ZrO_2 is 2360°C.[1] The natural Brazilian oxide, which contains from 75 to 85 per cent of ZrO_2, has a much lower fusion point, about 2000°C, which varies according to the composition. The thermal conductivity and coefficient of expansion are both considerably lower in zirconia than they are in the other refractory materials. The specific gravity of natural zirconium oxide is 4.55 while that of fused zirconia is 5.80. This increase in specific gravity is, of course, accompanied by a corresponding shrinkage.

Laboratory Ware

Crucibles, tubes and muffles have been made of zirconia for use in electric furnaces at temperatures up to 2000°C and some of them seem to have given good service.

These articles are made of refined zirconium oxide which has been calcined at a very high temperature in an electric furnace. The usual method of manufacturing crucibles consists of grinding the calcined zirconia very

[1] Otto Ruff and George Lauschke, "Preparation of Articles of Zirconia," *Z. anorg. Chem.*, **97**, 73 (1916).

fine, mixing with an organic bond such as starch, shaping the crucible, drying very carefully, and burning in an electric furnace to a temperature as high as that at which the crucible is to be used.

Laboratory ware for lower temperature work has been made from natural Brazilian oxide, bonded with good plastic clay.

Zirconia Brick

Zirconia brick are made from natural Brazilian oxide by a process very similar to that used in making magnesite or chrome brick. Because of the shrinkage, it is necessary to calcine the material at 1450°C or above before making brick.

The calcined zirconia is very hard to grind and it is common to mix about 75% of calcined zirconia ground to pass 20-mesh with 25% of raw zirconia ground to pass 150-mesh. The material is tempered in the wet pan and the brick are made in the special press which is used for making magnesite brick. The brick are dried with magnesite brick in tunnel dryers, and burned to cone 18 in the same kiln with magnesite brick.

The brick have the following characteristics:

Chemical analysis		
ZrO_2	75.02%	Fusion point 2000°C
Fe_2O_3	3.84%	Sheared in standard load test at 1520°C
TiO_2	0.85%	Porosity 19.41%
Al_2O_3	3.58%	Specific gravity 4.75%
SiO_2	16.62%	
	99.93%	

The cold crushing strength is greater than that of magnesite brick.

Zirconia brick show excellent resistance to slag penetration. Alkalies and fluorides attack them readily, however.

In the standard spalling test a zirconia brick showed an average loss of 3% each dip until the ninth dip. After ten immersions the brick broke in half. In view of the density and low thermal conductivity of the brick this resistance to spalling is remarkable.

Zirconia brick have been successfully used around the cinder line of forced draft boilers, where the service is very hard, and also in the firing zone of oil-fired furnaces.

The high cost of zirconia brick has been the main reason for the slow development of a large tonnage business, although given volume the cost can be reduced materially. The cost of the brick is below that of some other specialized refractories now in general use, but above that of magnesite and chrome.

Zirconia Cements

Zirconia cements are made from calcined Brazilian ore with plastic clay for a bond. The addition of 10% of clay does not lower the refractori-

ness seriously and makes a cement which is adhesive and which has good working qualities.

A pier of silica brick which contained $^3/_8$-inch joints of this cement was heated to 1500°C and held at that temperature for $1^1/_2$ hours under a load of 25 pounds per square inch. The cement did not show any signs of failure at this temperature. The cement has been used very successfully in laying up malleable furnace bungs and as a protective coating for boiler settings.

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TESTING OF REFRACTORIES

BY R. M. HOWE[1]

Twenty-five years ago most high temperature operations were conducted on a much smaller scale. The temperatures involved were lower and the other conditions of service were less severe. Consequently, less difficulty was experienced in securing suitable refractories and the art of testing had been developed to a very slight extent. Aside from a few chemical analyses and softening point determinations, practically all tests were made under operating conditions. With the use of higher temperatures the problem of selecting refractories has become difficult and the art of testing has been developed to a high degree. The development of several of the more important tests will be considered separately.

One of the oldest tests is that in which the softening or fusion point of the refractory is determined. Consequently, it has been developed to a high degree of perfection and has been standardized by the American Society for Testing Materials. Much of the successful use of this particular test may be attributed to the use of Orton cones. They furnish a cheap, accurate, reliable, and simple method for measuring the point of softening. The publications of Kanolt[2] are conspicuous in this particular field of testing.

A large portion of the credit for developing a satisfactory method of analysis should be given W. F. Hillebrand and H. S. Washington. Their methods for silicate and carbonate rocks are accurate and reliable although a trifle slow. Modifications of these methods are often made, however, at the expense of accuracy.

One of the most important tests to be developed since 1900 is that in which refractory bricks are tested at high temperatures under pressure. The first experiments were conducted by Lemon Parker[3] and reported

[1] Industrial Fellow, Mellon Institute of Industrial Research, University of Pittsburgh, Pittsburgh, Pa.

[2] J. W. Kanolt, "Melting Points of Refractory Materials," *Trans. Amer. Ceram. Soc.*, **15**, 167 (1913).

[3] Lemon Parker, "Action of Refractories under Load Conditions at High Temperatures," *Trans. Amer. Ceram. Soc.*, **7**, 185 (1905).

in 1905. He used fire-clay blocks in the application of pressure to fire-clay shapes in order to develop stronger tile for use in gas benches. His simple experiments led to the development of the load test by Bleininger and Brown[1] (1910), to the construction of special equipment by Montgomery[2] (1918) and to the more rapid ball impression test devised by Messrs. Unger, Nesbitt and Bell[3] in 1916.

Another one of the more conspicuous tests is that in which the refractory brick are heated for a period of time at a relatively high temperature in order to determine their permanency of volume. The first results to be reported were those of Seger and Cramer[4] in 1900. Loomis[5] made a number of these tests upon American fire-clay brick in order to develop a relationship between it and the load test. As a result a specification was written and this was later adopted by the American Society for Testing Materials. Ross[6] made similar tests on silica brick in order to determine their residual expansion. Jones, Harvey and McGee of the Semet Solvay Company contributed to the value of the test by extending it over a period of 72 hours. While this test gives extremely valuable information a number of the results indicate that a further study of the fundamentals controlling the volume changes in fire-clay brick is necessary.

Investigations by Ross,[6] Harvey and McGee[7] have shown that the residual expansion in silica brick may be estimated from specific gravity data. Although this practice was first recommended in 1917, its application has already been extensive and has led to results of decided practical value.

Practically all of the contributions to the development of a satisfactory slag test have been made within the past decade. The publications of Brown,[8] Nesbitt and Bell,[9] and Fischer[10] are conspicuous. Brown's method

[1] A. V. Bleininger and J. H. Brown, "The Behavior of Fire Brick under Load Conditions at a Temperature of 1300°C", *ibid.*, **12,** 337 (1910); **13,** 210 (1911).

[2] R. J. Montgomery, "A Furnace for Testing Refractory Materials under Pressure at High Temperatures," *Chem. & Met. Eng.*, **18,** 18 (1918).

[3] C. E. Nesbitt and M. L. Bell, "Practical Methods for Testing Refractory Fire Brick," *Proc. Am. Soc. Testing Mat.*, **XVI-II,** 351 (1916).

[4] Seger and Cramer, "Physical and Chemical Properties of Fire Brick," *Stahl u. Eisen*, **20,** I, 640 (1900).

[5] G. A. Loomis, "The Porosity and Volume Changes of Clay Fire Brick at Furnace Temperatures," *Jour. Amer. Ceram. Soc.*, **1,** 384 (1918).

[6] D. W. Ross, "Volume Changes in Silica Brick," *Trans. Amer. Ceram. Soc.*, **19,** 83 (1917).

[7] Harvey and McGee, "Testing Coke Oven Refractories," *Jour. Amer. Ceram. Soc.*, **4,** 474 (1921).

[8] J. H. Brown, "A Method of Testing the Corrosive Action of Slags on Fire Brick," *Trans. Amer. Ceram. Soc.*, **18,** 277 (1916).

[9] Nesbitt and Bell, *op. cit.*

[10] H. D. Fischer, "Looking for a Brick," *Combustion*, Feb., **1920.**

involved the heating of brick in a relatively large bath of slag. The method of Nesbitt and Bell is based upon the action of 35 grams of slag for 2 hours; it was adopted as a tentative standard by the American Society for Testing Materials, but has never been accepted as a standard. Fischer determined the fusion points of slag-brick mixtures in order to study the effect of the slag. McDowell and Howe[1] used crucibles made from the refractory material in studying the action of open hearth slags upon basic materials.

Of all these methods, that proposed by Fischer appears to be the most practical and simple; its further development should lead to a satisfactory test.

Most of our knowledge regarding the spalling test has been gained within the past decade, three contributions having been made on this subject. McDowell,[2] in studying the spalling of silica brick, determined their loss in strength during heating and cooling. Nesbitt and Bell[3] have studied the spalling of fire-clay brick by repeated immersions of the hot brick in water. Howe and Ferguson[4] supplemented this study and found that vitrification, as well as heating and cooling, was a vital factor. This test appears to have been developed to a high degree of perfection.

Other tests that have been developed or applied during the last 25 years are those which determine porosity, modulus of rupture, crushing strength, resistance to impact and abrasion, thermal and electrical conductivity, etc. These have not been applied extensively, however, and will not be discussed in detail.

In closing, the writer wishes to mention the importance of such tests as were inaugurated by J. M. Knote[5] and continued by Bleininger and Loomis.[6] The study of raw materials by means of porosity volume change curves gives fundamental information of decided value. The results have a direct application in a great many cases where the requirements are definitely established.

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[1] McDowell and Howe, "Basic Refractories for the Open Hearth."

[2] J. S. McDowell, "A Study of the Silica Refractories," *Bull. Amer. Inst. Min. Eng.*, **119**, 2001 (1917).

[3] R. M. Howe and R. F. Ferguson, "A Study of Spalling," *Jour. Amer. Ceram. Soc.* **4**, 32 (1921).

[4] J. M. Knote, "Physical Changes in Clay Due to the Influence of Heat," *Trans. Amer. Ceram. Soc.*, **12**, 226 (1910).

[5] Bleininger and Loomis, "Properties of American Bond Clays," *ibid.*, **19**, 601 (1917).

IMPROVEMENTS IN THE MANUFACTURE OF ZINC REFRACTORIES DURING THE LAST TWENTY-FIVE YEARS

By George C. Stone

Zinc refractories are best divided into two groups: (1) those made by the commercial producers and purchased from them by the smelters; (2) those made by the smelters for their own use.

The first group includes much the larger part of the refractories used and also the greatest variety of shapes and sizes. It comprises linings for smelter furnaces, retort and condenser kilns, melting furnaces and gas producers. A few of the smelters make their own furnace linings, but by far the greater number purchase them in the open market. The improvements that have been made in the manufacture of this class of materials are the same as those that have been made in similar materials for other purposes, and are in no sense peculiar to zinc smelting, and therefore need not be considered here.

The second group of refractories includes retorts and condensers which are made by the smelters themselves. It is necessary that retorts should be made by the smelters as they cannot be burned until they are to be used, and they must be taken from the kiln and placed in the furnaces at once, without being allowed to cool off. Condensers are always made by the smelters but there is no reason that they should not be made by outside manufacturers, although this would seldom be economical, on account of their bulk, which would make the freight on them very high.

There has been a considerable improvement in the manufacture of retorts in all points. Greater care is being given to the selection of the materials, and several companies have devised methods of testing both clay and grog that insure the rejection of unsuitable material. It is becoming more customary to give the materials a preliminary pugging, and to store the mixture in beds or cellars to "rot." Anyone who has gone into one of these cellars will appreciate the appropriateness of this term. In the case of most clays the treatment considerably increases the strength of the material, both dried and burned. The time the mixture should be "rotted" varies with each clay, and must be determined by experiment.

The outstanding improvement in the manufacture of retorts is the general substitution of the hydraulic press for hand work or tile machines. The presses are not only more economical but they give more uniform and durable retorts that are denser and can be made with much thinner walls. This last possibility allows of an increase of 10 to 12% in the capacity of the furnace. This is of itself a sufficient reason for the adoption of the presses.

The first practicable retort press was patented in France, July 24, 1874, by Émile Dor-Delatre, and all of the presses used in this country are constructed on his principle, although many improvements in details and methods of operation have been made here. The Dor press consists of a cylinder, with two concentric plungers that can be moved independently, and two movable heads. The head next the cylinder contains a die that determines the shape of the outside of the retort, and the outer head is solid, merely serving to close the apparatus. To operate, both plungers are lowered, a cylinder of clay is formed that contains sufficient material to make the retort, and is placed in the cylinder of the press. Both heads are locked and the inner plunger is forced up into the clay, driving it up into the die and forming the butt of the retort. The upper head is then unlocked and opened and pressure applied on the outer plunger, which forces the clay out between the head on the inner plunger and the die, forming the retort. This is cut off at the desired length and removed to the drying rooms.

Mr. Dor patented an improved form of his press in this country on May 9, 1905 (U. S. No. 789,451). It presents some advantages but is much more complicated and has not been used here as far as I can ascertain. Improvements in retort presses have been patented by a Mr. Charles Albert Wettengel, of St. Louis, February 25,1913 (U. S. No. 1, 054,064), and September 29, 1914 (U. S. No. 1,112,103); and by Mr. John J. Simmonds, of Iola, July 14, 1914 (U. S. No. 1,103,320), and February 17, 1920 (U. S. 1,331,285 and 1,331,286). These are extensively used and are reported to give satisfaction. All are improvements in the details and mechanical means of operating the presses and not changes in principle. Mr. J. J. Simmonds built a press with but one plunger, which forced the clay out between two dies, the inner being carried by arms from the sides of the die-head. It was simpler to build and operate than the Dor type, but the necessity of slitting the clay as it passed the arms supporting the inner die and reuniting it was a serious disadvantage.

Many spelter works potteries are now constructed with the drying house divided into small rooms, in which the temperature and humidity can be controlled independently, giving much better and more uniform drying. This also tends to give better and more uniform retorts.

The first machine for forming the cylinder of clay to be put in the press was a drop hammer which forced the clay into a cylinder against the pressure of a ram, which also forced the clay out of the cylinder when the operation was completed. This was slow, did not always give sound cylinders and caused many injuries to the operators. In some plants this has been replaced by a vertical pug mill, which discharges against a ram, or by a horizontal pug mill with a floating shaft. Either of these does more rapid and economical work, without danger to the workmen.

The manufacture of condensers has been cheapened and the quality of the product improved by the introduction of machines for their manufacture. Of these there are two types. In both a ball of clay is placed in a conical mould and a revolving mandrel is driven into it, pressing the clay against the mould and forming the condenser. In the first system, patented by Messrs. J. J. Turner and J. A. Dowler, of Le Harpe, Kansas, February 16, 1904 (U. S. No. 752,484), and also by Messrs. Russell Garrison and George W. Whipple, of Cherryvale, October 19, 1907 (U. S. No. 915,848), the plunger is lowered into the mould. In the second, patented by Lewis E. Vanatta, of Iola, Kansas, October 2, 1906 (U. S. No. 832,177), the mould is raised to the plunger. Both are doing satisfactory work in many places.

Many patents have been taken out for new materials for retorts and for lining retorts but none of them are generally used. The basic retort lining patented by Benjamin Stadtler, February 6 and June 26, 1900 (U. S. 642,722 and 652,332), was used a good deal in the Southwest, when the ferruginous Colorado ores were first smelted, and was reported to give good results. Experience with these ores, however, showed that the same results could be more cheaply obtained by varying the conditions in the furnace and this type of retort has been generally abandoned.

Mr. A. L. Queneau patented the manufacture and use of retorts with linings of graphite, and of retorts containing a layer of graphite between two of clay. Both were tried and showed advantages, but these were not sufficient to justify the increased cost.

Several companies are at present experimenting with new refractories but so far none have progressed far enough to make the results public. It is however probable that some better material than clay will be found.

NEW YORK CITY

THE HISTORY OF THE DEVELOPMENT OF SILICON CARBIDE REFRACTORIES

BY CHARLES F. GEIGER

The possibilities of the use of silicon carbide (carborundum) as a refractory were realized by Acheson at the time he first produced this important compound. In the original patent covering the production of silicon carbide (E. G. Acheson, U. S. Patent No. 402,767, February 28, 1893) its highly refractory character was pointed out. In a lecture before the Franklin Institute[1] he stated ". . . . . its three prominent characteristics—great hardness, infusibility, and incombustibility—are sufficient to warrant its extensive introduction into special lines."

[1] E. G. Acheson, "Carborundum—Its History, Manufacture, and Uses," *Jour. Franklin Inst.*, Sept. (1893).

No specific mention was found in the limited amount of literature examined under dates of 1893 to 1898 on the use of silicon carbide as a refractory, and it is probable that its commercial applications during that period were not numerous.

On Dec. 6, 1898, Acheson was granted patent No. 615,648 on a method of bonding silicon carbide for refractory uses through the media of iron, iron oxide, or salts of iron. Patent No. 628,288 was granted July 4, 1899, to Benjamin Talbot for a "neutral lining for furnaces" composed of silicon carbide and a bonding agent. F. A. J. Fitzgerald was allowed two patents on May 22, 1900, pertaining to methods of bonding silicon carbide for refractory purposes by recrystallization in the electric furnace.

The first large-scale commercial utilization of silicon carbide for refractory purposes began about 1903 with its use in the manufacture of retorts for the zinc industry in Germany and Belgium. This resulted mainly from the work of Engels who took out several German and English patents covering zinc retorts and silicon carbide refractory paints. The painting of ordinary fire brick with silicon carbide was practiced to a considerable degree, but the results were not marked with much success. However, the use of silicon carbide, in amounts of 60 to 65% with 40 to 35% of fire clay, has been the regular practice in the manufacture of zinc retorts by the more important zinc plants of Germany, Belgium, and France. In 1912 and 1913 large numbers of silicon carbide shapes were made in Germany for special furnaces used in the smelting and recovery of zinc.

An application for United States Patent filed April 25, 1905, by F. J. Tone contained specifications pertaining to the use of silicon carbide bonded with clay and sodium silicate as a lining for brass-melting furnaces. The silicon carbide used for this purpose, as stated in the specification, was the fire sand variety, the amorphous variety, or the crystalline variety. Although this patent was not granted until October 29, 1912 (No. 1,042,844), the original work served as the foundation for a tremendous usage of carborundum fire sand, which is believed to be either mixtures of small particles of crystalline or amorphous silicon carbide or both and silica, or a solid solution of silicon carbide in silica to give compounds of the formula Si_xC_yO, for the linings of non-ferrous melting furnaces. The success of the fire sand for certain furnace linings led to its manufacture into shapes for other refractory purposes. These products proved their worth in a great many instances, but as time went on it was learned that it was impossible to make the highest grade of silicon carbide refractories from carborundum fire sand and that it was generally necessary to employ crystalline silicon carbide in shapes for installations other than non-ferrous melting furnaces.

In 1912, F. J. Tone received Patent No. 1,013,700 on the silicidizing of

carbon forms by exposure to silicon vapors to form a special variety of silicon carbide refractory, and previous to that date he was granted Patent No. 992,698 on a silicon carbide refractory bonded by recrystallization.

F. A. J. Fitzgerald[1] speaks of fire sand linings, and silicon carbide pyrometer tubes and other shapes formed in the silicidizing and recrystallizing processes; he also makes special mention of the high heat conductivity of silicon carbide. Under the title of "Carborundum Refractories," F. J. Tone[2] discusses the properties of silicon carbide refractories, describing chiefly the bonded varieties made from crystalline grain. This is the earliest article found in print descriptive of silicon carbide refractories that approach those of present development. A quotation from this article emphasizes a very important point: "when bonded with a clay binder carborundum brick have very great refractory value. However, it is recognized now that the ideal condition to be obtained is that the amount of binding material used be the least consistent with the requisite mechanical strength and that the vitrification temperature of the binder be as high as commercially practical. Failure to realize these essential conditions has been the cause for the indifferent success of Carborundum refractories where their use first appeared most promising."

The foundation for this type of refractory is found in Patent No. 1,204,211 granted to F. J. Tone on November 7, 1916, which, however, was applied for in 1913. This serves as the basis of the present technical development of crystalline silicon carbide refractories in this country.

In 1913, then, the following varieties of silicon carbide refractories were employed in the industries of the United States:

Bonded fire sand, which were made from carborundum fire sand, clay and sodium silicate and formed "in place."

Recrystallized, which were made from crystalline grain formed into the shapes desired and recrystallized in the electric furnace to effect a bond.

Silicidized, which were made by the siliconizing of carbon forms.

Bonded, which were made from crystalline grain with small amounts of refractory bonds and burned in ceramic kilns.

Prior to 1914 recrystallized silicon carbide refractories in the form of brick were being utilized in stoker settings and as base blocks for graphite crucibles, while a number of muffles were in use in heat-treating furnaces.

In the period from 1912 to the present, United States patents were granted on the bonding of silicon carbide for refractories to August Pfaff, T. B. Allen (2), F. J. Tone (3), G. A. Balz, and M. L. Hartmann, and to S. C. Linbarger on the use of silicon carbide in graphite crucibles.

[1] *Met. and Chem. Eng.*, **10**, 129 (1912).

[2] *Ibid.*, **11** (1912).

Just at the time when silicon carbide was starting to make great strides forward into the refractories field, the European war resulted in such a tremendous demand for grain for abrasive purposes that except for fire sand for rammed-in linings, it was not available in this country in large quantities for refractory uses. During the years 1914 to 1918 many orders for refractory shapes had to be refused by the largest producing companies because of the scarcity of grain; despite these handicaps, however, noteworthy progress was being made in improving the quality of the product and in the widening of its scope of application. During this period, increasing quantities of recrystallized and bonded brick were meeting success along the clinker line in traveling grate stokers, and the roofs of certain types of electric furnaces were effectively lined with these brick, while the applications of small muffles and pyrometer tubes increased. In this interval also, the clay bonded shapes, because of their lower production costs and ease of manufacture into more difficult shapes, had been replacing the recrystallized silicon carbide refractories. Cements also received attention, and muffles for the Dressler Tunnel Kiln were first made. Retorts for the carbonizing of coal were also produced.

The year 1919 saw increasing use of silicon carbide brick in boiler settings, the first full brick linings in water-gas generators, more hearths and supports for heat-treating furnaces, more roofs for electric furnaces, and more tunnel kiln muffles. During this year silicon carbide refractories were first used in glass leer construction. The 1920 developments were most important; and in this year was established the first plant in the United States and possibly in the entire world devoted entirely to the production of silicon carbide refractories. Early in 1920 the first porcelain enameling muffle made of silicon carbide was installed in this country. At about the same time a large number of low temperature carbonizing retorts were built. Silicon carbide shapes were finding considerable use in heat-treating and other oil-fired furnaces because of their ability to resist the flame impingement and high temperature. It was known, of course, that silicon carbide could not stand contact with molten basic slags, and it was learned that silicon carbide brick would not endure in settings of boilers that were being operated at high overratings when the mid-western high-iron coals were being burned, because the iron slags attacked the brick. By 1920 the recrystallized refractories had, in a large measure, been superseded by a bonded type burned at high temperatures in ceramic kilns. During 1921 refractories of this type came into considerable usage in oil-fired marine boilers, oil- and coal-fired stationary boilers, combustion chambers for oil, carbonizing retorts, porcelain enameling muffles, glass leers, heat-treating furnaces, and muffle furnaces for metallurgical purposes. The use of silicon in carbide zinc retorts had also become a standard practice with certain zinc producers in this country. The great

strength of silicon carbide refractories at elevated temperatures allowed the construction of very thin-walled muffles; the high heat conductivity effected fuel savings and production increases to such a degree that in two years these muffle installations increased to hundreds.

In 1922, several periodic kilns with silicon carbide muffles were erected in the pottery industry. During this year all the established lines increased their demands for silicon carbide refractories. The knowledge that has come to light on the efficacy of radiation as a means of heat transfer led to the construction of several types of thin-walled silicon carbide radiating furnaces which insure practically perfect combustion with oil, gas, or pulverized coal and which are capable of consuming sufficient fuel to produce about three times as many heat units per cubic foot of combustion space as any other type of furnace all because of the high heat conductivity and emissivity of property bonded silicon carbide. Chief among the developments along this line was the construction and operation of the first successful furnace ever built for making sponge iron on a commercial scale. This product is used for the precipitation of copper in solution by replacement. As a result of the large output of sponge iron possible for production in the rotary hearth radiating furnace, the established metallurgical processes for the recovery of copper are being revolutionized. During this year radiation furnaces were applied also to japanning ovens, oil stills, and boiler settings.

In the United States at the present writing, silicon carbide refractories find their chief output in the following forms:

Bonded, which consist of crystalline grain with small amounts of refractory bonds and which are burned to high temperatures in ceramic kilns.

Bonded fire sand, which are made from carborundum fire sand and suitable bonds and are "rammed-in" or are shaped and burned at the place of manufacture or are formed at the place of fabrication, shipped dry, and burned "in place."

Refractory cements and furnace washes, which are made from crystalline grain and a series of bonds providing for different vitrification ranges and softening points.

To summarize: Chief among the applications at the end of 1922 are oil-fired furnaces, high and low temperature carbonizing and other retorts, porcelain enameling muffles, glass leers, fireboxes, crucibles, zinc retorts, boiler settings, heat-treating and annealing furnaces, gas generators, muffle kilns, radiating furnace sand linings for non-ferrous melting furnaces.

In the earlier days of silicon carbide refractories the extreme refractoriness and great strength were thought to be the most important properties, but the high heat conductivity and the excellent radiating ability have

proved these refractories to be so eminently successful in the saving of fuel both at high and low temperatures that the major portion of all the installations made are for indirect heating units such as retorts and muffles. With the work that is being done on the development of silicon carbide refractories it is becoming increasingly obvious that the field for the application of these refractories does not lie chiefly in the replacement of natural fire clay and silica in the linings of existing types of furnaces although many successful applications have been found in this field. Today several new kinds of furnaces are being built that depend chiefly upon the utilization of the conductivity and emissivity of silicon carbide refractories. It is rather in this field of new development that this refractory seems destined to offer the greatest service. During the past years many kinds of furnaces and combustion equipment and many proposed metallurgical and chemical processes have been carried forward to the failure of the then available refractories. Within the last three years a number of these have again been attempted, and with the utilization of silicon carbide refractories failures have been turned to success.

In the early introduction of silicon carbide refractories many installations were made that seemed predestined to failure; this was done with the idea of determining the limitations of the material so that once its possibilities were ascertained more attention might be diverted to the successful applications. This accounted for a number of the early failures, as did the fact that it was not possible to make perfect silicon carbide refractories with one or two years' experience. It is now known that the working limits allowable in the production of first quality silicon carbide refractories are very small and that unless an article comes within this small field, even though it may be only slightly under quality, it is unlikely to be successful.

LOOKING BACKWARD IN THE TERRA COTTA FIELD

By A. F. Hottinger

Terra cotta as a building material in the United States dates from the late sixties and was then made in a crude way and in limited quantities for use as a decorative material and was mostly made of red burning clays, so that it was often painted and passed for other material.

With the introduction of buff burning clays and the use of grog to control shrinkage and assist in drying, the manufacture of terra cotta broadened and it took its place as a structural building material. It is notable that even at this early date it was recognized that to be durable it was necessary to have a hard burned material, and in looking back it is notable that very few cases of failure of terra cotta through weathering or freezing exist. At this time the use of machinery for grinding and preparing clay was very crude, crushers being of the coffee mill type and fine grinding

being done on buhr mills. Mixing was done by dumping the dry material on the floor, adding water and having men tramp the mixture to coherence when it was put through a pug mill.

With the use of buff burning clays the range of color available increased considerably as it was possible to mix the red and buff clays and also to add the cheaper oxides so that grays, browns, pinks and other colored bodies were made. Also at this time the use of barium carbonate to prevent the soluble sulphates from coming out on surfaces exposed to weather was discovered. Shortly after this period the process of flashing the buff burning clays came into use and this added a new range of color which was very popular for some time.

The introduction of barium carbonate into bodies about 1885 also opened up another important epoch in the industry since with its use it was possible to apply engobes to the buff body which very much widened the range of color, making it possible to use clays and oxides which otherwise would be out of the question on account of the expense involved. With the use of engobes it was also possible to apply a vitreous coating so that the material gained greatly in value.

It may be said that at this point is where the ceramic chemist first became of value to the industry as no great amount of technical knowledge was available, little being published or known.

With the advent of the ceramic chemist some of the problems of the business were brought into control—one of the early and important was the control of burning to secure a thorough oxidation of the ware before reaching the finishing temperature, thus doing away with ware coming from kilns with what was called steamed or pink, and mottled with iron spots which did not match in color.

Until this time or about 1890, no glazed or enameled ware was produced, but with the advent of the tall office building, the demand for this class of material took definite form, since a material was desired which would at once be easily cleaned and reflect light so necessary in the courts of these buildings.

It was but a short step from this point that enameled ware became very popular for the exterior of building and its use spread very rapidly. In its early stages enameled ware was made in a two-fire process, but this, being expensive, compelled the manufacturers to proceed with some technical and scientific research and this may be said to be the point at which the trained ceramist proved to be invaluable to the successful manufacture of this class of work.

As now made enameled terra cotta is universally made by the single-fire method and the various manufacturers have solved the problems involved in various ways, there being a wide difference in enamels and methods used. Clays adapted to the manufacture of terra cotta in the different parts of

the United States varying in their range of heat necesssary to produce a good hard body have caused this difference in processes, which extend not only to enamels but also to methods of mixing and drying.

With the ceramist in the laboratory and the researches conducted the range of products produced by the various manufacturers increased and it would take more space than I have to even give a partial list, but at present glazes and enamels in all colors are produced and with the introduction of these, the use of polychrome in architecture is possible and is slowly making a field for itself. It is unnecessary to say that there are still unlimited fields in this direction which give opportunity for research and which will open new fields for this class of material. In the burning of terra cotta no great changes have been made since the necessity of burning in muffle kilns has limited any economics or processes applicable to this class of material.

There are, however, a number of experiments in this direction which promise to make this an interesting field and such possibilities lie in the direction of the tunnel and gas-fired kiln to which much attention is being given.

With the wide market for terra cotta at present and the rapid expansion of the various manufacturers, many problems were passed which demanded attention. Some of these are common to all, but the investigation and research necessary have made it impossible for any one manufacturer to undertake them.

The various manufacturers under the guidance of the National Terra Cotta Society have arranged with the National Bureau of Standards to undertake the investigations. A very large amount of work has been done but nothing of a conclusive nature has been reached. This investigation has in view the requirements of a good terra cotta body and the work so far has included studies in the hardness, porosity, strength and resistance to freezing, but the field is so large that a considerable amount of work is still necessary before any conclusion can be drawn.

TECHNICAL DEVELOPMENT IN THE WHITEWARE INDUSTRIES

By F. K. Pence

It is impossible to present within the scope of a brief report a history of the several crafts or even the technical development of the industries concerned with the manufacture of the semi-vitreous and vitreous products. To attempt this would require laborious research and would result in a voluminous report.

Historically considered the manufacture of semi-vitreous tableware was produced at East Liverpool by William Bloor in 1860. This was a true porcelain hand decorated and may be taken as a starting point of the whiteware industries in its evolution from the yellowware. This porcelain was

made on a commercial basis as the ware was taken down the river on trading boats and sold in southern markets. Through a loss of men on account of the Civil War and through financial difficulties the factory was closed in 1863, but from this beginning there were developed later the various types of vitreous products for tableware, electrical porcelain, sanitary porcelain and tiling.

The beginnings of the various phases of the potting industry in Ohio have been listed in the following manner by Wilbur Stout of the Ohio State Geological Survey:

Earthenware pottery, William McFarland, Cincinnati, Oct. 17, 1799
Stoneware, Samuel Sullivan, Zanesville, 1808
Yellowware, James Bennett, East Liverpool, 1840
Whiteware, William Bloor, East Liverpool, 1860
Whiteware, Tempest Brockman & Co., Cincinnati, 1867
Earthen cooking and serving ware, G. H. Bodine & Co., Zanesville, 1878
Sanitary ware, J. H. Baum, Wellsville, 1888
Chemical porcelain, Guernsey Earthenware Co., Cambridge, 1916
Chemical porcelain Ohio Pottery Co., Zanesville, 1916
Door knobs, John Goodwin, East Liverpool, 1845
Electrical porcelain, R. Thomas & Co., East Liverpool, 1884

Beginning with the semi-vitreous products known as general ware for table use we find its development centered chiefly about Cincinnati, East Liverpool and Trenton districts.

Having its origin in England the industry followed the practices of the Staffordshire pottery centers with remarkable fidelity and for many years no fundamental changes in its processes were made. In this respect the peculiar relations between the master potter and the organized operative potters must be considered which have always made innovations difficult to accomplish. Of recent years through the advent of improved drying systems and the tunnel kiln the need of more radical changes is being clearly recognized. The manufacturers themselves have taken active steps to bring about coöperative research and the study of factory problems and have inaugurated a system of coöperation with the Bureau of Standards and other agencies which might well serve as an example of industrial progress. A number of the larger plants have established control and research departments. The question of having one or more laboratories to serve groups of the smaller plants is now under consideration. There can be no doubt but that the general ware industry is entering upon a period of industrial development of no mean magnitude.

The ambition to produce vitreous tableware was in the minds of many early manufacturers and records show that Homer Laughlin in East Liverpool had produced porcelain covered both with high fire and softer glazes and also that the Knowles, Taylor and Knowles Co. produced a

bone china of high quality. But it remained for others to create a typical industry, which followed neither the bone china of England nor the soft bisque- hard glaze porcelain of Continental Europe. They developed a typical, non-absorbent body of a stony rather than glassy texture, possessing extraordinary toughness, and a borosilicate glaze for it. In this they followed the practice of the earlier ware industry in using a higher bisque than glost fire.

In the development of this industry the names of James Pass and Ernest Mayer stand out prominently, both charter members of this SOCIETY. Of these, that of Ernest Mayer is especially noteworthy as he was both a potter and a scientific investigator, possessed of deep knowledge and a broad sympathy, which will ever be remembered by his contempories. Mayer did much to promote the vitreous tableware industry and we may say, therefore, that it truly was nourished in its infancy by technical thought. Having more complicated problems than the earthenware industry, more attention had to be given to technical details and we find as a consequence that its leaders were closely affiliated with the work of the SOCIETY. At the present time technical departments are in operation in several plants, and coöperative research work is being done with the Bureau of Standards.

From the standpoint of artistic excellence the exquisite vitreous porcelain made by Lenox Inc., of Trenton, represents the highest development and justly ranks with the most famous ceramic art products of the world.

The production of high fire porcelain was not entirely unrepresented during the years of early development inasmuch as the old Union Porcelain Works of Brooklyn has been in existence for a long period. A strong impetus to this particular development, however, was not imparted to it until the outbreak of the European war when the need for chemical porcelain stimulated its manufacture. In this development the figure of John Herold is probably the most outstanding. It was he who began the making of hard fire chemical porcelain both at Golden, Colorado, and at Zanesville, Ohio, now represented by the Coors Porcelain Co., and The Ohio Pottery Co., respectively. From the technical standpoint the work of the Bureau of Standards in this direction, especially that by F. H. Riddle, deserves mention. The present status of the chemical porcelain industry is such that its continued existence and growth are assured.

With the development of the electrical industries of the country the manufacture of insulating porcelain became a prime necessity and developed into an industry of considerable magnitude. Starting with the making of dry pressed porcelain for low voltages there is now being produced a non-absorbent porcelain of high quality. Among the pioneers in this field there may be mentioned the R. Thomas Co., of East Liverpool, Ohio, and the Locke Insulator Co., Victor, N. Y. The subject of insulator porcelain was first studied from the technical standpoint by A. S. Watts,

whose many contributions in this field are well known. The technical activities pertaining to this branch of industry, both from the electrical and ceramic standpoints are very marked and will tend to be more so in the future as very high tension currents become necessary for the distribution of power over large areas.

The extensive growth of the sanitary porcelain industry parallels the development of modern and typically American requirements. Its home is Trenton from whence it has spread to many other states. Considered from the technical standpoint it has been in the quiescent state for a long time, without the introduction of new manufacturing features. But the pioneering work of C. J. Kirk in the application of the casting process and the tunnel kiln is bearing fruit and more rapid advance is taking place at the present time.

In the field of floor and wall tile we have both vitreous and partially vitrified ware. The principal seat of this industry where its first development took place and the first technical work was done by Langenbeck and Stanbery is Zanesville, Ohio. Ever since Langenbeck's time the technical development has kept pace with the exacting requirements inherent in this product. This industry has furnished the SOCIETY with another of the early presidents, F. W. Walker, whose contributions have been not only along technical lines but also with the organization of an industry for coöperative effort from the economic standpoint.

There might be noted also the development of special porcelains, such as the Marquardt body, used in the making of pyrometer tubes, which was introduced in this country by the Bureau of Standards. The first work on this subject was done by G. H. Brown. The same Bureau has contributed also an investigation dealing with the synthesis of mechanically strong porcelains which possess high electric resistance at elevated temperatures of which the authors are A. V. Bleininger and F. H. Riddle. It is possible that the principles brought out in this work may have a bearing on the development of insulators for currents of extremely high voltages.

The keynote of the modern point of view in industrial relations is cooperative effort on the part of the manufacturers belonging to a given branch of industry. Such coöperation is to be both economic and technical. One of the prime needs of this group effort must deal with the perfection of the product in order that it may be possible to combat competitive materials. This must be the fundamental motive underlying cooperative effort and in the striving toward a more and more perfect product, the application of scientific principles to the manufacture of the white clay products will become a matter of necessity. If this general principle is realized we shall be able to maintain the rate of development in a manner worthy of the developments of the past.

THE KNOWLES, TAYLOR AND KNOWLES CO.
EAST LIVERPOOL, OHIO

A HISTORICAL SKETCH OF THE ELECTRICAL PORCELAIN INDUSTRY IN AMERICA

By C. C. Treischel

Porcelain Mixtures

Although the manufacture of porcelain is a very old art—the credit of the origin and development being given to China, where the industry flourished during the middle ages, the use of porcelain as an electrical insulation is comparatively recent. The Germans were the first to use porcelain for this purpose and as nearly as can be ascertained the date of this initial application was about 1852. At that time in attempting to lay telephone wires underground it was found that they could not be properly insulated with gutta-percha, the chief insulating material then in use. Mixing clay with the gutta-percha and finally vulcanizing the gutta-percha with sulphur did not produce satisfactory results. This led to overhead construction but the same troubles of unsatisfactory insulation were encountered. The gutta-percha clay mixture was more satisfactory than the vulcanized material due to the fact that the latter attacked and corroded the copper wires and this fact led to the use of baked clay and finally the more or less vitrified porcelain.

In America so far as the writer can learn the first electrical porcelain was made by the dust or dry process and the credit for this accomplishment goes to the Greenwood Pottery Company of Trenton, N. J. This was in 1879. The articles were two-piece insulators, probably knobs, and were given two firings, one biscuit and one glost. Mr. Joseph Crossley of Trenton made the dies used in making these pieces and at the same time laid the foundation of what is now the Crossley Machine Company.

Mr. David Crossley, now president of the Crossley Machine Company, feeling that the electrical porcelain industry presented a very large field and unlimited opportunities, started experimenting with different articles, bodies and glazes in 1890–91. His samples were fired by the different potters in Trenton. Experiments being constantly retarded by waiting for the return of his samples, a delay of two weeks being customary, Mr. Crossley became discouraged with his arrangement and decided to try glazing an unfired piece just to see what might happen to it during firing. Lo and behold! The piece on coming from the kiln could not be distinguished from his twice-fired samples. Realizing that he had discovered a method of making electrical porcelain at a greatly reduced cost and by a much quicker process, he erected a small test kiln in the cellar of his home and continued his experiments with the one-fire process for two or three years, thus perfecting his formulas. On April 25, 1895, he organized and incorporated the Electrical Porcelain and Manufacturing Company of Trenton, the first electrical porcelain factory in the world to devote its entire production to the one-fire process.

The year prior to the organizing of the Electrical Porcelain and Manufacturing Company saw the first use of electrical porcelain for insulation against high voltages and it was the Imperial Porcelain Works of Trenton, N. J., who in 1894 made our first wet process high tension insulators. Mr. Fred M. Locke of Victor, N. Y., who in 1902 formed the Locke Insulator Mfg. Co. (now the Locke Insulator Corporation), also made wet process insulators about this same time.

Compared with our present insulators for high voltages these first attempts would probably be considered rather crude; but these first manufacturers deserve great credit for, although their product will not stand the criticisms of our present engineers, they laid the foundation of our great (operating and contemplated) electrical transmission lines. And when one considers that in the last 30 years operating voltages have increased from a few thousand volts to 220,000 volts their contribution to the advance of the electrical industry should be still more appreciated.

Machinery and Equipment

With but few exceptions the machines and processes used in the manufacture of electrical porcelain can be said to be adaptations from the general pottery practice. Of course certain manufacturers were pioneers in their introduction but ordinarily the fundamentals come from some other branch of the whitewares industry. This does not mean, however, that the electrical porcelain manufacturers were backward in this respect, but rather that their resourcefulness had to be expended in supplying the rapidly increasing and varying demands of the electrical engineer regarding size, shape and dielectric strength. And the pug mill illustrates this point very well for, although it has been the source of great losses ever since wet process insulators were first made, it is still the universal machine for forming wet process blanks.

As stated above some manufacturers were pioneers in the use of certain machines and processes and a résumé of some of the most noteworthy follows.

The manufacture of wall tubes was at one time a tedious and expensive process but the ingenuity of Mr. G. F. Brunt gave us the machine which upsets the head of the tube so that today such tubes are very inexpensive. And to enable us to have tubes of most any length the Colonial Sign and Insulator Company in 1894 developed the suspension method of supporting them during the firing.

Glaze was at first applied by dipping the ware into glaze vats, but the unfired porcelain pieces absorbed the glaze so rapidly that a thin coating could not be obtained except by the most skilled dippers. Even then small holes in the case of dry process porcelain would become filled and time lost

in cleaning the glaze out of them. August Weber of the Weber Electric Company tried spraying the glaze and found the method satisfactory. Today spraying of glaze is the rule in most dry process plants and some very ingenious automatic spraying devices have been developed.

In the manufacture of transmission line insulators the pull-down jigger was for quite a number of years the omega of development. With this machine one side of the insulator is formed by a plaster mold and the other side by a wood or metal template—the mold of course revolving on the jigger. It was about 1910 when someone (the credit for this innovation has not been determined) tried plunging a heated die into the porcelain mass in the mold. The steam formed by the hot metal in contact with the wet mixture acted as a lubricant and the price of line insulators dropped. Recently the use of metal to replace the plaster mold has been tried and the Pittsburgh High Voltage Insulator Company was the first to use the method in this country.

To the General Electric Company goes the credit of introducing to the industry two pieces of equipment and one process, all three of which were radical improvements over existing methods. These are:

(*a*) The Continuous Tunnel Kiln	1913
(*b*) The Casting Process	1914
(*c*) The Continuous Humidity Drier	1917

In the field of spark plug porcelains the practical use of the French Kneading Table was introduced by the Champion Ignition Company. This company also developed a method of applying surface combustion principles to a continuous tunnel kiln, firing glazed porcelains in open saggers to cone 16 (1917). In 1919, the Jeffery-Dewitt Company, now the Champion Porcelain Co., succeeded in successfully operating a Dressler type tunnel kiln continuously at cone 18, the highest commercial operating temperature for car tunnel kilns in America.

The developments in the field of electrical porcelain have in the past kept pace with the rapidly growing electrical industry. With this growth has come the feeling that technically trained men are a valuable asset, and as there is every reason to believe that the ranks of the ceramic engineers will be kept full, the electrical porcelain industry in America should continue to produce the best electrical porcelain in the world.

General Electric Company
Pittsfield, Mass.

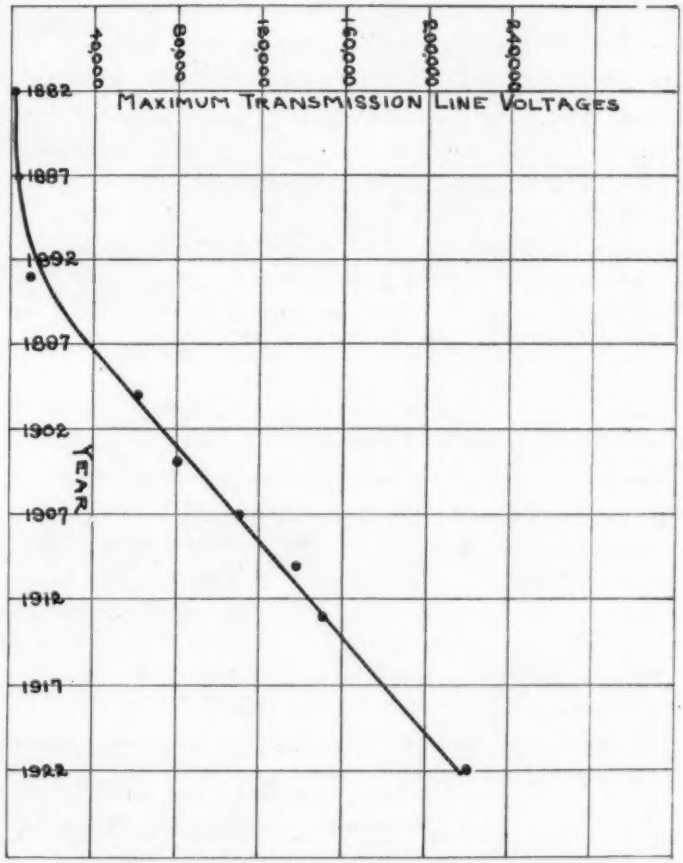
HIGH VOLTAGE PORCELAIN INSULATORS IN UNITED STATES CHRONOLOGY

By J. S. Lapp

Up to

1895—Glass insulators used

1895—Use of porcelain ("china") insulators begun. Ordinary whiteware body adopted for high-voltage insulators.



Pioneers—Fred M. Locke, Victor, N. Y.
Frederick Duggan, Imperial Porcelain Works, Trenton, N. J.
J. W. Boch, R. Thomas & Sons Co., East Liverpool, O.
J. Coxen, Electric Porcelain Co., Trenton, N. J.

Aging of clay thought to be valuable.

1898—Fred M. Locke at Victor, N. Y., builds first factory devoted exclu-

sively to high-voltage insulators, introducing brown glaze instead of white, heretofore standard.

1899—First 60,000 volt insulators built by Locke at Victor. 120,000 volt testing outfit installed for these insulators.
Ultimate insulator design reached.

1904—First use of English ball clay for insulators.
Benefits of aging clay thought to be due to bacterial action.

1907—First use of suspension type insulators.
Pug-mill trouble still requires attention.

1910—Introduction of "cast" porcelain for some classes of insulators.

1912—Strong efforts made to introduce German insulators, but without success. One deterring factor was the soft glazes as compared with the hard glaze single fired U. S. product.
Ultimate insulator design reached.

1913—Industry discovers that since adoption of suspension types, extensive insulator failures have occurred. Engineers divided as to opinions of cause. Some say it is due to porous porcelain; others say it is due to relative expansion and contraction of porcelain and metal parts.
Introduction of dye solution impregnation tests for porosity.
Aging of clay considered necessary, especially for difficult designs.

1919—First use of Lapp clay kneading machinery. Requiem for pug-mill.

1922—Growing doubt that ultimate insulator design reached.
Peak voltage for transmission stands at 220,000 with 300,000 volts contemplated.
Ceramic progress during past 15 years as affecting high voltage porcelain insulators marked by greater uniformity in vitrefaction, better methods of treatment of clay to produce greater homogeneity, and therefore greater electrical and mechanical strength, and the growing conviction that larger improvements are ahead than behind.

THE STORY OF SPARK PLUG PROGRESS

By Taine G. McDougal

Although as late as 1910 this country was dependent upon Europe for the better grades of spark plug insulation, it is significant of the progress which has since been made that burned insulators and even raw clay bodies are now being exported to both England and France, to be assembled in those countries into plugs for the European markets.

Along with the first developments of internal combustion engines, the

original hot platinum tube ignition, which a strong gust of wind would extinguish, was replaced by the low tension (about 4 volts) "make and break" or "jump spark" system. This latter came into use in France about 1896 as equipment on a one-cylinder tricycle made by de Didion. With the importation of these tricycles most probably came the first spark plugs used in this country; and their general design was practically the same as is used today.

Insulation requirements for this low tension system were not very exacting, even those insulators machined from raw steatite giving acceptable service. Blin of near Limoges, a manufacturer of small porcelain cups for artists' colors, happened to be using a composition which at that time proved more or less satisfactory for spark plug insulation; and this same concern exported raw porcelain body to this country until the beginning of the War when German occupation interfered.

Just as Blin's body was eagerly "adopted" for the manufacture of spark plugs in France, so at the beginning were American manufacturers satisfied to adopt porcelain bodies as then used in the general and electrical porcelain factories of this country. Soon, however, objections arising from excessive breakage due to temperature shocks demanded that these borrowed bodies be adapted to better suit the special spark plug requirements. At this time better insulating value than that afforded by most any porcelain material was not necessary.

However, during this period of rather slow improvement in quality of product, manufacturers in this country did greatly improve manufacturing processes. Hand throwing and hand turning, which all English and French manufacturers are employing to this day, were early discarded on this side for the semi-automatic throwing and turning machines. While one "hand thrower" could produce only 3000 cylindrical blanks in one day, 17,000 has for some years been standard production for one girl operating the improved throwing machine. During this earlier stage of spark plug development, America forged far ahead in production methods but lagged behind in bettering the quality of the product itself.

Improvement in internal combustion motors soon called for higher cylinder compression and a higher operating temperature. More certain functioning of the spark then demanded higher (15,000) voltage ignition. And for some time improvement in high temperature insulation scarcely kept abreast of the rapid strides of this automotive progress. The same insulation which gave satisfactory service in ordinary automobile motors, actually blocked further motor improvements during the development in 1915, of the Packard 12-cylinder air-plane motor which, with a few changes, later became the Liberty motor of the U. S. Army.

Measurements made with special apparatus, devised in the laboratory of one of this country's largest corporations to compare insulating values

of various materials and compositions at the elevated temperatures prevailing in these high compression motors, disclosed the detrimental effect on thermo-dielectric value of one of the porcelain body ingredients which had heretofore been considered essential in the production of high quality "electrical porcelain." These data which were soon afterwards checked and added to by findings made at the Bureau of Standards laboratories, clearly indicated elimination of feldspar to be a most simple and certain procedure to assure an insulator of greatly increased thermo-dielectric value.

The use of any satisfactory substitute for feldspar entailed higher burning temperatures, cone 15 to 16 being necessary with feldspar only partially eliminated, while cone 18 and higher was desirable if it were to be entirely eliminated. With super-refractories not yet available the problem presented was one of refractory kiln materials attending the raising of burning temperatures above the current cone 12 practice. Just as motor progress was awaiting spark plug development so in turn was spark plug progress delayed for want of suitable refractories.

Solution was attempted in two directions—(1) search for better refractories for kiln construction and for saggers, and (2) mitigation of the punishment of those refractories which were already available. Before either of these lines of investigation could be completed the urgency of immediate war requirements for plugs in quantities, later amounting to 40,000 daily, for Liberty aircraft equipment, forced a compromise. Throughout the war all Liberty motors and a large proportion of other aircraft motors used by the Allies were equipped with spark plugs using a feldspathic porcelain insulator fired to cone 15 in periodic coal-fired kilns. The feldspar content was of course reduced to the allowable minimum but no artificial or synthetic substitute was introduced, maturity being effected by use of higher temperatures.

With war pressure relieved, synthetic substitutes for feldspar were commercially developed until such of the better insulations as are now in use can no longer be claimed to have been "borrowed" from one of the older branches of porcelain manufacture.

The idea of lessening the punishment of kiln refractories as mentioned in a former paragraph, led to the development of a tunnel kiln especially adapted to firing spark plug insulators to the high temperatures now in practice. In this kiln the porcelains are passed through in a single layer, the saggers or trays in which they stand, really being a part of the car deck, with no super-imposed weight to promote deformation.

The rapid strides made by the spark plug industry have been practically forced by feverish progress in automotive development. This association with the automobile industry first made itself felt in the radical changes in production processes effected after but a brief trial of those methods as

at first brought from Europe or borrowed from the other clay industries of this country. And as the automotive industry was founded on research, so the associated spark plug industry was bound to benefit. Spark plugs are made to meet a demand and so long as the demands of automobile engineers become no more modest or less insistent than they have been in the past, no fear need be held for the future progress of the spark plug industry.

SANITARY WARE MANUFACTURE IN AMERICA

By R. H. Minton

Previous to the early '70's all the sanitary ware used in the United States was imported from England. One or two attempts had been made to manufacture it in America but the difficulties were found to be too great, and all efforts had been abandoned.

The first successful manufacturer of sanitary ware in this country was Thomas Maddock, who began its manufacture in 1873 in Trenton, N. J. The difficulties encountered were those which usually attend the beginning and evolution of a new industry. To develop a proper body for heavy sanitary porcelain was quite different from making table or toilet ware. To this was added the lack of skilled operatives, all of whom had to be trained. There were no kilnmen who knew how to place such large pieces. The glaze dippers did not know how to handle such ware. As a result the kiln losses were extraordinarily heavy due to warping, dunting and crazing.

After much time, with great perseverance and unceasing labor, Mr. Maddock finally succeeded in producing an article that compared with the imported product. Even then it could not be sold except when stamped as an English brand.

The development of sanitary ware marks the development of sanitary engineering. Plumbing has made possible modern civilization in cities, and has been the greatest single factor in advancing the health of the human race.

The most important product of the sanitary potter has been the water closet. This was first introduced in about 1850 in London. The beginning was of a crude form and its evolution has been through the usual successive steps to perfection. Many inventions marked the progress of its development, the principal ones relating to the flushing rim and the syphon jet. The present style of improved bowl is a combination of all of the best principles.

It is interesting to note that in America the development of sanitary ware has always been in advance of sanitation generally. In fact, the manufacturer of sanitary ware has been a better promoter of modern sanitation

than either the plumbing trade or the medical profession. As a result, sanitary conditions in America are superior to those of any other country in the world.

The improvement in sanitary ware has been largely due to the co-operation of the potter, who has made it possible to produce in an impervious clay body the most difficult and intricate shapes. While the old fire clay closet bowl is still used to a large extent in England and Europe, it is unknown in the United States. The sanitary ware of this country, both as regards quality of ware and perfection of design, is superior to that of any other country.

The sanitary ware industry may be divided into two branches: the vitreous china ware, including principally closet bowls, tanks, and lavatories; and the so-called "solid porcelain" plumbing fixtures, bath tubs, wash trays, kitchen sinks, lavatories, urinals, shower receptors, slop sinks, etc.

The industry is one in which a large amount of hand labor is involved. The great bulk of the ware is formed by hand and so far no serious attempts have been made to form by machinery except in case of tanks. There seems to be no reason, however, why certain types of lavatories cannot be formed by machine pressing.

Perhaps the greatest departure from the old method is in the casting system of forming the ware. The casting method is quite generally used in Germany, and to some extent in England, but has not until recently been given serious consideration in the United States. In the greatest sanitary ware center, Trenton, casting has not made much headway due to opposition on the part of the union operatives. In the newer plants of the middle West casting has been extensively employed. Owing to the present strike among the employees of the potters in the Sanitary Potters' Association, it is likely that casting will receive a great impetus in the East.

The other most important development that is now being tested in the industry is in the use of the tunnel kiln. It is too early to reach a definite conclusion as to the results. In some plants it has been reported to be a success, while in others the particular type used has been a complete failure. Some eight or ten kilns have been built, or are in operation, in this industry and their development is being watched with great interest.

In England there has been developed a compartment kiln which is giving great success in the firing of sanitary ware. It seems likely that a kiln of this type will be a great factor in the future development of firing in this industry. Both the introduction of casting, and a more compact and economical method of firing, should make great headway on account of the necessity for eliminating labor and reducing costs.

From the single firm started in 1873 by Thos. Maddock (now known as the Thomas Maddock Sons Co.) the industry was rapidly expanded until there are now more than sixty firms engaged in the manufacture of

sanitary ware. Of these about eight or ten are making the heavy grog ware while the others make vitreous ware. The output of the manufacturers of vitreous sanitary ware have a capacity equivalent to about 300 beehive kilns which include the equivalent of that through the tunnel kiln. The industry employs approximately 6000 employees and the yearly production value will approximate between $25,000,000 and $26,000,000.

General Ceramics Company
Metuchen, N. J.

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The following is a list of books to be found in the libraries of the University of Illinois, New York State School of Ceramics, Carnegie Library of Pittsburgh, Ohio State University and the private library of F. H. Rhead. Thanks are due to the librarians of the ceramic departments and especially to E. H. McClelland, Technology Librarian of the Carnegie Library, of Pittsburgh. There has been no attempt to prepare a *complete* list of ceramic books, this list being compiled only in response to many inquiries for titles of books to be found in the libraries.

For more complete lists see Sources for Additional References, p. 347.

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Gratacap, L. P.	A Popular Guide to Minerals. 1912	D. Van Nostrand Co., New York City
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Merrill, G. P.	Non-Metallic Minerals. 1904. 2d ed. 1910	J. Wiley & Sons, New York City
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Klooster, H. S. van	Lecture Demonstrations in Physical Chemistry. 1919	Chemical Publishing Co., Easton, Pa.
Landolt, Hans, and Börnstein, R.	Physikalisch-Chemische Tabellen. 2d ed. 1894. 3d ed. 1905. 4th ed. 1912	Julius Springer, Berlin, Germany
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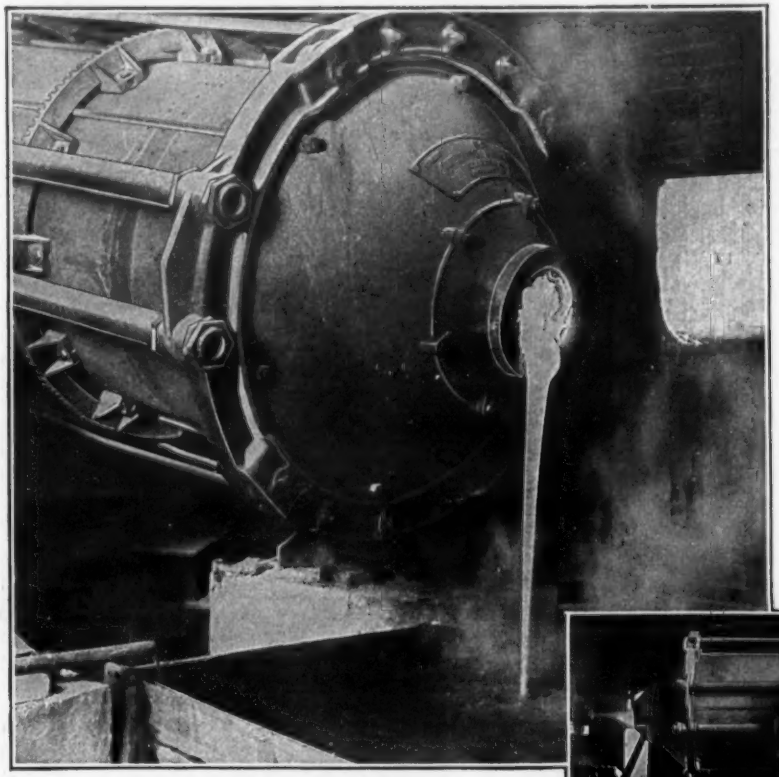

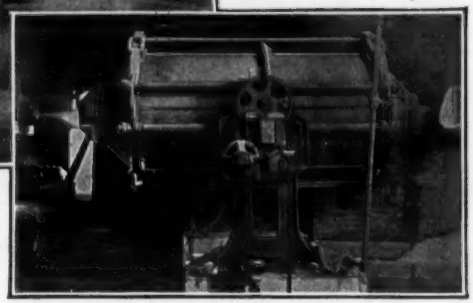

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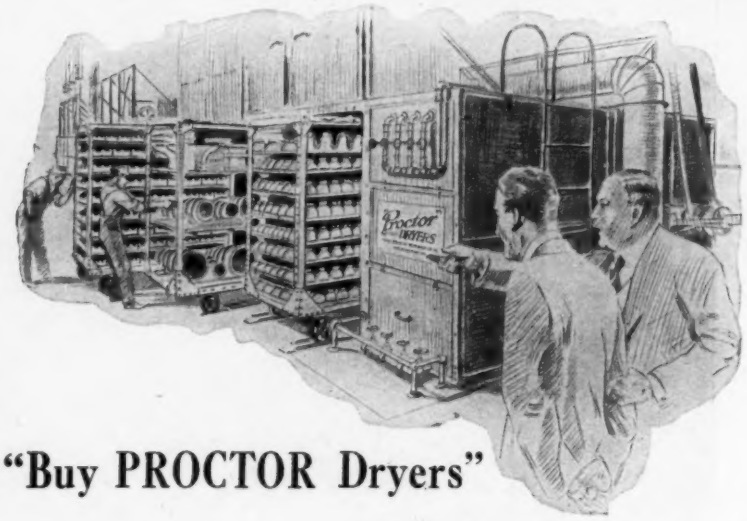

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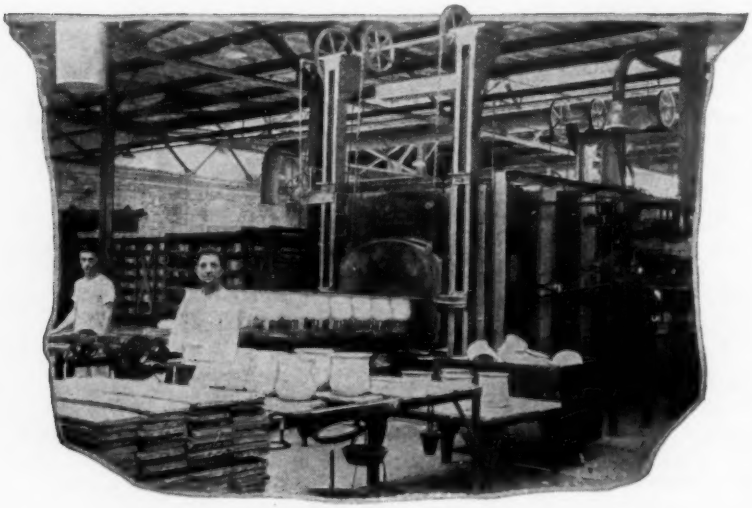

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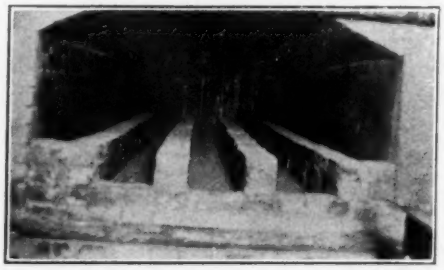

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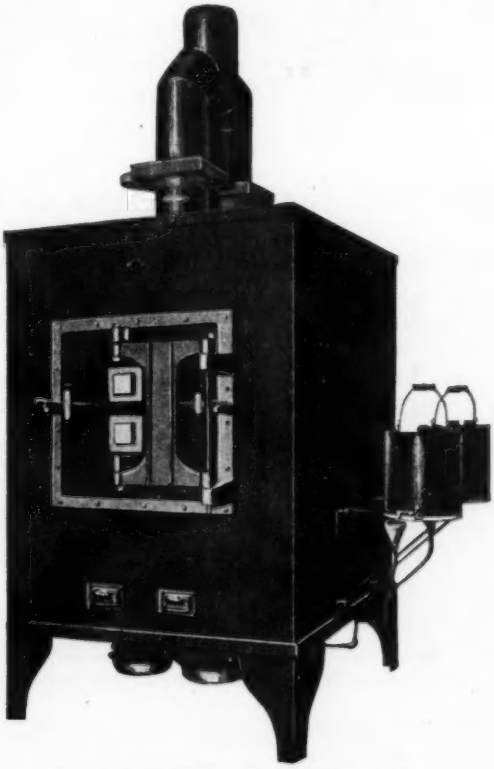

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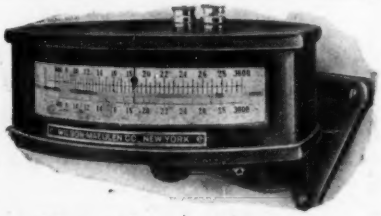

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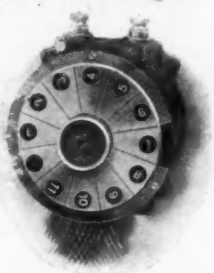

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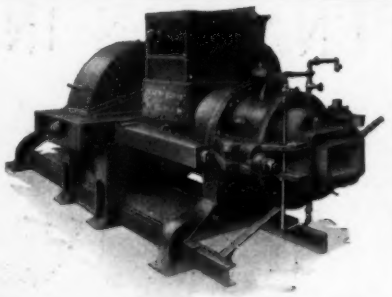

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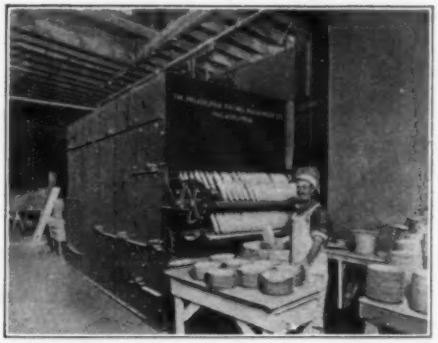

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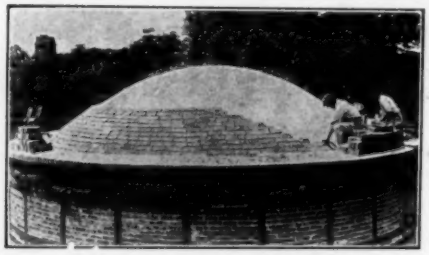

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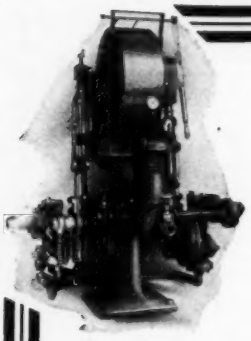

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